Essays on Empirical Macroeconomics

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Memoria presentada para aspirar al grado de

DOCTOR POR LA UNIVERSIDAD DE ALICANTE

Mención de Doctor Internacional

Doctorado en Economía Cuantitativa

Dirigida por: Prof. Fidel Pérez Sebastián
Acknowledgements

It has been a great privilege to study in Alicante. Doing research in economics at Universidad de Alicante while being surrounded by the vibrant life of this unique city, wonderful people, and amazing food has truly been an experience of a lifetime. Many people have helped me in writing this thesis, for which I am eternally grateful.

First and foremost, I would like to express my deepest gratitude to my supervisor, Fidel Pérez-Sebastián, for providing me with valuable guidance and outstanding support along the way. Thorough feedback and constructive criticism received through all these years are also highly appreciated.

Next, I would like to thank Ádám Reiff and the Research Department of the Magyar Nemzeti Bank for hosting me as a visiting scholar, as well as for the invaluable insights into central banking which I have gained during my research stay. I am also indebted to Jean Imbs and the faculty at the Paris School of Economics for providing an excellent research environment and for the opportunity to present my work at the Macro Workshop during my academic visit. Parts of the third chapter were written while I was visiting the Research Centre of the Deutsche Bundesbank. I wish to separately acknowledge and thank my very good friend and co-author, Norbert Metiu, for his warm hospitality and stimulating conversations while I was in Frankfurt, and afterwards.

Further, I owe my greatest thanks to all fellow students and faculty at Universidad de Alicante, past and present. This dissertation would be different without the intellectual atmosphere, helpful discussions, and insightful comments that contributed significantly toward my overall professional development. Moreover, I must acknowledge the administrative staff of the department for their kind service and assistance.

I also wish to thank all my friends in Alicante, Budapest, and in the rest of the world for the good chats, great laughs, and many unforgettable moments, even in the most difficult times. True friends will always be there.
My family deserves a special mention for not only offering support during the development of this thesis, but throughout my entire life. I am especially thankful to my parents and siblings for their belief in me, and for providing me with the encouragement to pursue my dreams.

Finally, last but certainly not least, I would like to most sincerely thank Eszter for her patience, understanding and limitless support during this challenging process. My studies, my research, my formation as an economist and a human being would not be possible without your help and love.

Mihály Tamás Borsi
Alicante, July 2015
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Introducción

El crack financiero que comenzó en los Estados Unidos en 2007 se extendió rápidamente a muchas economías avanzadas y emergentes y se transformó en la crisis financiera mundial más grave desde la Gran Depresión. El contagio a la economía real ha sido particularmente grande y dio lugar a recesiones en la mayoría de los países avanzados. Estos acontecimientos han planteado una serie de importantes preguntas acerca de los vínculos entre el sector financiero y las fluctuaciones económicas, así como de la eficacia de las políticas fiscales, monetarias y macroprudenciales en este contexto. La literatura emergente, ejemplificada por el trabajo de Jermann y Quadrini (2012), demuestra que las perturbaciones financieras juegan un papel crucial en la generación de los movimientos del ciclo económico, especialmente a través de la demanda de trabajo. Por otra parte, Borio (2014) y Aikman, Haldane y Nelson (2014) argumentan que las fricciones financieras dan lugar a ciclos financieros distintos del ciclo económico, que se caracterizan por una menor frecuencia y mayor amplitud. Ignorar estas características puede socavar el poder de las política económica, sin embargo, aun cuando estos hechos sean tenidos en cuenta, las políticas convencionales pueden no ser suficientes para estimular la economía. Por ejemplo, algunos países pueden utilizar la política monetaria tradicional para afectar al ciclo financiero, pero para otros, como los que están en una trampa de liquidez, esta opción no está disponible. Otros pueden tener una alta deuda y menos margen para llevar a cabo una política fiscal contracíclica. Además, la experiencia reciente de los estados miembros de la Unión Europea ha demostrado que en los países altamente integrados, el éxito de un marco normativo común depende en gran medida del grado de la convergencia económica. De hecho, la particularmente lenta recuperación de la última recesión sugiere que la diversidad estructural y divergencia económica puede poner en peligro el enfoque político de talla única (“one size fits all”) defendido por los partidarios de la unión político-económica.
Motivado por los nuevos retos planteados por la crisis financiera de 2007-2008, el objetivo de mi tesis es contribuir al campo de la macroeconomía empírica desde una perspectiva econométrica aplicada. La tesis consta de tres artículos independientes en su contenido, sin embargo el denominador común que une a todos ellos es la alta relevancia de sus implicaciones para el diseño de políticas económicas óptimas en el futuro próximo. Los dos primeros ensayos se centran en dos aspectos clave de los vínculos macrofinancieros. El Capítulo 1 investiga la relación entre las fricciones financieras y el rendimiento del mercado laboral, y explora cómo las contracciones de crédito privado en particular afectan a las fluctuaciones en el desempleo. El Capítulo 2 analiza las diferencias en el impacto de las políticas fiscales a lo largo del ciclo de crédito. Basándose en la conjetura de que los multiplicadores fiscales dependen fundamentalmente del entorno financiero, el estudio examina cómo los efectos de los cambios en el gasto público varían dependiendo del estado de los mercados de crédito, según sea esta expansivo o contractivo. Por último, la creciente inestabilidad en la Unión Europea y la incertidumbre sobre la moneda común en los años recientes ha dejado claro que, en los países altamente integrados, la convergencia económica constituye un requisito previo para el correcto funcionamiento de las políticas estructurales y monetarias comunes. Por lo tanto, el Capítulo 3 trata de comprender la evolución de la convergencia macroeconómica en la Unión Europea en los últimos cuarenta años.

A continuación paso a describir cada uno de los capítulos con más detalle.

El primer capítulo investiga la relevancia empírica de las imperfecciones en el sector financiero para la dinámica del mercado de trabajo. Este tema es de gran importancia debido principalmente a las graves consecuencias de un alto nivel de desempleo que deben ser tenidas en cuenta por los políticos. El análisis de las interacciones entre los mercados financieros y laborales ha inspirado en una nueva línea de investigación sobre macrofinanzas tras el estallido de la reciente crisis financiera mundial. Desde entonces, una gran cantidad de estudios ha documentado el papel de los factores financieros en la conformación de las fluctuaciones macroeconómicas (por ejemplo, Brunnermeier, Eisenbach y Sannikov, 2012, y los artículos a los que hacen referencia), y hay pruebas convincentes de que las fricciones que subyacen a las crisis financieras se derivan principalmente – aunque no exclusivamente – de los desajustes en los mercados de crédito (Schularick y Taylor, 2012). Además, otras contribuciones relacionadas sugieren que un canal clave a través del cual estas perturbaciones se propagan directamente a la economía real es la demanda de trabajo. Por ejemplo, Jermann y Quadrini (2012) desarrollan un modelo que incorpora deuda y financiación del capital para estudiar los efectos macroeconómicos de los fallos en el sector financiero, y demuestran que los shocks de crédito...
han desempeñado un papel importante en la dinámica del mercado de trabajo y de la producción en la economía de los Estados Unidos en las últimas décadas. Bentolila, Jansen, Jiménez y Ruano (2013) y Chodorow-Reich (2014) analizan el impacto de los grandes shocks de oferta de crédito en el empleo a nivel empresarial en España y en los EE.UU., respectivamente. Ambos artículos explotan las diferencias en las condiciones crediticias al comienzo de la Gran Recesión, y muestran que las reducciones inesperadas en los préstamos bancarios tienen un efecto considerable en el nivel de empleo. A pesar de la creciente literatura sobre los posibles mecanismos por los que las variables financieras y reales interactúan, los trabajos empíricos que abordan los vínculos entre las fricciones financieras y la evolución del mercado de trabajo desde una perspectiva global son escasos. En este artículo se pretende llenar este vacío proporcionando nueva evidencia sobre la relación entre las contracciones de crédito privado y el desempleo en un análisis comparativo de varios países a lo largo del tiempo.

En particular, examino el impacto de las caídas en el nivel de crédito privado sobre el desempleo, utilizando un panel de 20 países de la OCDE que abarca el período 1980-2013, desde tres dimensiones. En primer lugar, proporciono una medida directa del grado en que las contracciones del crédito afectan el desempleo total, juvenil y de larga duración. En segundo lugar, exploro la hipótesis de que las reducciones en el volumen de crédito que surgen después de las expansiones crediticias altamente apalancadas tienden a ser seguidas por un desempleo más grave y un periodo de recuperación más lento. Esta conjetura se apoya en la idea de que el aumento del apalancamiento eleva la fragilidad financiera de la economía debido a la asunción de riesgos excesivos y criterios en la concesión de préstamos más laxos, mientras que un mayor volumen de deuda privada se va acumulando (por ejemplo, Pagano y Pica, 2012; Jordà, Schularick y Taylor, 2013). En tercer lugar, también investigo el papel de las instituciones del mercado laboral, ya que la variación en el tamaño del impacto durante las contracciones puede deberse a diferencias en la flexibilidad de la regulación laboral (Blanchard y Wolfers, 2000; Nickell, Nunziata y Ochel, 2005).

En cuanto al marco metodológico, el efecto dinámico de las contracciones de crédito sobre el mercado de trabajo se identifica mediante el uso de un enfoque de predicción directa propuesto por Jordà (2005). En concreto, la senda media acumulada del desempleo para el conjunto de países se calcula con el método de proyecciones locales para los años siguientes al comienzo de un episodio contractivo. Para ello, construí un indicador binario de las contracciones de crédito para cada país de la muestra empleando el algoritmo de Bry y Boschan (1971). Las funciones de respuesta al impulso se estiman por separado para el desempleo total, juvenil y de larga duración. La variación diferencial
en la respuesta del desempleo es capturada a través de la distinción entre los efectos de las caídas de crédito graves y no graves, donde una contracción se clasifica como grave si la disminución en el crédito privado se encuentra en el cuartil superior de todas las contracciones de crédito detectadas en la muestra, y como no grave en caso contrario. Para estudiar cómo el grado de desempleo varía con la intensidad del apalancamiento financiero de una economía, extiendo el modelo base con un término de interacción que mide la tasa de variación anual del crédito privado en cada episodio expansivo que precede a una fase de contracción del crédito. En la última parte del análisis, relaciono el indicador binario de las contracciones de crédito con distintos niveles de regulación laboral definidos por un índice compuesto de la flexibilidad del mercado laboral. Esto me permite explicar cómo las fricciones del mercado laboral pueden amplificar los efectos adversos de los colapsos de crédito. Los potenciales problemas de endogeneidad se abordan mediante la realización de varios análisis de sensibilidad, incluyendo la estimación del impacto de las contracciones de crédito que comienzan durante expansiones económicas, especificaciones alternativas del modelo de referencia y un análisis submuestra para ver si los resultados son robustos a la exclusión de la Gran Recesión.

Los resultados del primer capítulo revelan que las disrupciones en el mercado de crédito privado pueden generar grandes fluctuaciones de desempleo. Para comprender la importancia cuantitativa de los resultados, las contracciones de crédito representan entre un tercio y la mitad del aumento total del desempleo en la muestra en los cuatro años siguientes al comienzo de una contracción. El efecto máximo se produce, en promedio, dos años después del comienzo de la caída del crédito y su duración total es mayor de cuatro años. Una contracción del crédito en un país de la OCDE suele ir seguida por un aumento de casi un 1% en el desempleo total en su máximo. El impacto en los trabajadores jóvenes es aún más pronunciado, ya que aumenta su tasa de desempleo en más de un 2,4%. Los efectos duraderos de la caída de crédito en el desempleo de larga duración indican un alto grado de persistencia y lenta recuperación. Además, las contracciones de crédito graves van seguidas por un mayor aumento en las tasas de desempleo que las caídas en el nivel de crédito más leves, con diferencias por valor de un 2% a medio plazo. Por otra parte, los resultados proporcionan evidencia de que las contracciones de crédito que siguen a las expansiones con alto apalancamiento financiero – en lugar de bajo apalancamiento financiero – generan, en promedio, incrementos hasta cinco veces mayores en el desempleo. Por último, la gravedad del impacto depende en gran medida de la flexibilidad de las instituciones del mercado de trabajo. Contracciones crediticias en las economías con regulaciones laborales más rígidas producen una tasa de desempleo sustancialmente más alta, especialmente entre los jóvenes.
La evidencia empírica sobre los vínculos entre la dinámica del mercado financiero y laboral exige un replanteamiento en el diseño de estrategias y de ajustes significativos en las decisiones políticas, mediante la incorporación del canal de la transmisión crediticia hacia el desempleo. Bajo la premisa de que las contracciones de crédito pueden transmitirse al mercado laboral, las políticas económicas dirigidas a la mejora de la regulación financiera y una mejor supervisión macroprudencial deberían ser capaces de mitigar las consecuencias negativas que las disrupciones de crédito provocan. Por otra parte, el artículo pone de relieve una preocupación existente a la que se enfrentan varias economías de la OCDE acerca de la actual salida de los jóvenes y los desempleados de larga duración de la población activa tras la reciente crisis financiera.

El segundo capítulo estudia los efectos macroeconómicos de los cambios en el gasto público a lo largo del ciclo de crédito. En un entorno económico como el de las últimas tres décadas, no es posible entender las fluctuaciones del ciclo económico y sus implicaciones políticas sin comprender el ciclo crediticio. Por un lado, los episodios de exceso de endeudamiento privado suelen ser seguidos por una crisis financiera que implica una contracción de los mercados de crédito y una caída fuerte de la actividad económica (por ejemplo, Mendoza y Terrones, 2012; Schularick y Taylor, 2012). Por otra parte, las crisis económicas asociadas con la caída de crédito tienden a ser más profundas y más prolongadas que las recesiones normales (Reinhart y Rogoff, 2009; Jordà et al., 2013). Además, la evidencia empírica sugiere que los ciclos de crédito tienen una frecuencia mucho menor y una mayor amplitud que los ciclos económicos tradicionales (Aikman, Haldane y Nelson, 2014). La incorporación de estas características fundamentales que han operado durante más de un siglo en las economías industrializadas plantea nuevos retos para los economistas, así como para el diseño de políticas económicas en todo el mundo. De hecho, los fallos revelados por la Gran Recesión han dado lugar a un intenso debate sobre los vínculos entre la macroeconomía y las finanzas, y han impulsado el estudio de las interacciones entre los ciclos económicos y financieros en la investigación de vanguardia.

En los años recientes se han propuesto una gran variedad de medidas para hacer frente a las subidas explosivas de crédito y las posteriores caídas, cómo intervenciones más activas de la política monetaria y nuevos instrumentos de política macroprudencial (por ejemplo, Mishkin, 2009; Gertler y Karadi, 2011; Borio y Zhu, 2012). Además, dado que las políticas monetarias convencionales suelen ser ineficaces durante las trampas de liquidez con tasas de interés próximas a cero, las herramientas fiscales han ganado cada vez más atención a raíz de la última crisis económica. No obstante, a pesar del auge de los estudios sobre el impacto de las políticas fiscales, la eficacia de las intervenciones del...
gobierno en resolver los desequilibrios financieros sigue siendo una pregunta abierta (Corsetti, 2010; Kuester, Meier y Müller, 2010; Ilzetzki, Mendoza y Vegh, 2013). Por lo tanto, el objetivo de este segundo capítulo es el de arrojar nuevas luces sobre las implicaciones del entorno financiero para el diseño de las políticas fiscales, mediante el análisis de los efectos macroeconómicos de los cambios en el gasto público a lo largo del ciclo de crédito. A este respecto, el estudio contribuye también a una creciente literatura que emplea modelos no lineales para evaluar el impacto de la política fiscal en expansiones y recesiones económicas, incluyendo Auerbach y Gorodnichenko (2012, 2013) y Riera-Crichton, Vegh y Vuletin (2015).

En el análisis econométrico, estimo funciones de respuestas al impulso dependientes del estado para un panel de 24 países de la OCDE entre 1985 y 2012 utilizando el método de proyecciones locales introducido por Jordà (2005), en el cual el tamaño del multiplicador depende del estado del ciclo crediticio. En concreto, los multiplicadores fiscales son evaluados bajo las condiciones financieras más extremas, es decir, durante los episodios de auge explosivo del crédito y las caídas de crédito más severas. Los shocks fiscales, es decir, las innovaciones imprevistas en el gasto público, se identifican utilizando los errores de predicción de las proyecciones del gasto público de la OCDE. Adicionalmente, al distinguir entre shocks positivos y negativos, el enfoque no lineal permite cuantificar la respuesta de las economías a los estímulos y medidas de austeridad fiscales en los diferentes regímenes del ciclo crediticio. Por último, a fin de evaluar la capacidad de la política fiscal en la reducción de los efectos adversos del ciclo de crédito, también exploró sus efectos en los componentes claves de la demanda privada, como consumo e inversión, y también en del desempleo. Una mayor comprensión de los mecanismos de transmisión subyacentes debería ayudar a enmarcar las decisiones de las políticas fiscales con el fin de dominar el sobrecalentamiento de la economía durante los auges de crédito excesivos, y revertir la espiral descendente de la demanda agregada cuando llegue la caída.

Las conclusiones de este artículo establecen la importancia de la situación de los mercados de crédito para predecir el grado en que la intervención fiscal puede tener eficacia en las economías de la OCDE. Los tres resultados principales que emergen son los siguientes. En primer lugar, las respuestas al impulso específicas para cada régimen muestran una reacción fuerte y estadísticamente significativa del PIB real a los shocks de política fiscal durante los episodios de contracciones crediticias severas. Por el contrario, cuando el crecimiento del crédito es excesivo, la respuesta promedia de la producción a un cambio en el gasto público es cercana a cero y no es significativa en términos estadísticos. En segundo lugar, la distinción entre los aumentos y disminuciones en el gasto del gobierno revela que una postura fiscal contracíclica es deseable tanto en las etapas en las que los mercados de crédito
Introducción son disfuncionales, como cuando la acumulación de crédito es abundante. A pesar de que los shocks de gasto público positivos podrían estimular la economía en los períodos de grandes expansiones de crédito, la consolidación durante los años de auge puede ayudar a incrementar el espacio fiscal para estabilizar el sector financiero e impulsar la recuperación económica cuando los mercados de crédito se derrumban. Por lo tanto, el compromiso con la disciplina fiscal en el régimen expansionista puede facilitar la estabilidad macroeconómica en el largo plazo a un coste relativamente bajo. En tercer lugar, los multiplicadores del consumo privado, el desempleo, y en particular, la débil respuesta de la inversión privada durante las contracciones de crédito sugieren que las políticas fiscales podrían ser más eficientes si el gasto público se dirige directamente a reparar y fortalecer los balances privados. Compensar el sistema financiero a través del restablecimiento del flujo de crédito a la economía, a su vez, recuperaría la confianza del mercado, atraería inversión privada, y restauraría el crecimiento económico.

El tercer capítulo investiga la evolución de la convergencia macroeconómica en la Unión Europea (UE). La severa recesión y el prolongado proceso de recuperación experimentada por varios miembros de la UE en los años recientes ha llevado a un renovado interés en la importancia de la convergencia económica en las economías altamente integradas, lo que implica que la convergencia constituye un ingrediente esencial para las políticas estructurales y monetarias comunes. Los países de Europa Occidental dieron importantes pasos hacia la integración económica en las últimas décadas, cómo la liberalización de los mercados de capital y de trabajo, la armonización de la política tributaria, y la fundación de la Unión Económica y Monetaria (UEM). Por otra parte, el Tratado de Maastricht de 1992 estableció una agenda para la convergencia macroeconómica antes de entrar en la unión monetaria, y la Comisión Europea ha presentado numerosas iniciativas políticas encaminadas a la reducción de las disparidades económicas regionales y la mejora de la competitividad entre los miembros de la UE (European Commission, 2007). Mientras tanto, en los países de Europa Central y Oriental (PECO) se llevaron a cabo importantes cambios políticos e institucionales en los años 1990. Estos procesos implicaron considerables ajustes macroeconómicos, por ejemplo, la transición de la economía planificada a la economía de mercado, la liberalización de los precios y la privatización de los activos estatales. Tras la transformación exitosa de su sistema político, legal y económico, estos países se han enfrentado a la tarea de ponerse al día con las economías de Europa Occidental (por ejemplo, Sachs, 1996).

Basándose en la hipótesis de que una mayor integración económica entre los países puede dar lugar
a un aumento en la convergencia de las rentas reales, este capítulo investiga cómo ha evolucionado la convergencia de la renta per capita entre los 27 Estados miembros de la UE entre 1970 y 2010. El artículo conecta con una gran cantidad de trabajos empíricos sobre la convergencia macroeconómica en Europa. Previamente se han considerado una variedad de métodos, así como períodos de muestreo diferentes, tanto a nivel regional y nacional, y la literatura ha llegado a conclusiones mixtas hasta el momento. Por ejemplo, Sala-i-Martin (1996) analiza la convergencia en la renta real per cápita para 90 regiones que abarcan ocho países europeos entre 1950 a 1990 y encuentra que los ingresos regionales convergen a una velocidad moderada. En contraste, Canova (2014) y Corrado, Martin y Weeks (2005) no encuentran ninguna convergencia global entre las regiones de Europa Occidental, pero detectan grupos de convergencia regional en toda Europa, que están fuertemente correlacionados con la ubicación geográfica y las características económicas. Otra línea de investigación sugiere que las diferencias en los atributos estructurales (por ejemplo, la tecnología de producción, las preferencias, y las políticas gubernamentales), así como las condiciones iniciales (por ejemplo, el stock inicial de trabajo y de capital físico y humano) son predictores significativos de la formación de clubes de convergencia (véase, por ejemplo, Durlauf y Johnson, 1995; Galor, 1996; Bartkowska y Riedl, 2012). En consecuencia, la convergencia de las rentas reales entre los países europeos sigue siendo un tema muy controvertido. Por esta razón, además de centrarse en la identificación de los clubes de convergencia, el tercer artículo analiza los diferentes tipos de dinámicas de transición económica en el camino hacia la convergencia. Este amplio enfoque permite ofrecer un exhaustivo conjunto de hechos estilizados sobre la convergencia económica en la UE.

El estudio emplea una prueba de convergencia empírica derivada de un modelo de crecimiento neoclásico, aumentado con el progreso tecnológico endógeno que difiere entre países y a lo largo del tiempo. El modelo presentado por Phillips y Sul (2007) captura una forma de convergencia comparable al concepto de la $\sigma$-convergencia condicional, que se refiere a la reducción de la dispersión de la renta entre países ricos y pobres, después de controlar por las características específicas de cada país. Hay varias razones que justifican la elección de esta metodología. Desde un punto de vista teórico, el método no se basa en el progreso tecnológico homogéneo entre países y a lo largo del tiempo, que es una suposición muy restrictiva, no obstante, ampliamente utilizada en la literatura existente. Otra gran ventaja de esta técnica es que, a diferencia de otros métodos de series temporales, no requiere la existencia de tendencias estocásticas comunes y, por tanto, permite que las trayectorias de transición individuales sean transitoriamente divergentes. Esto implica que la transición de cada economía hacia el nivel de estado estacionario de la renta real per cápita sólo depende de las tasas
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de crecimiento tecnológicas en cada país. En consecuencia, es posible trazar la senda de transición
de cada economía hacia el nivel de renta correspondiente con el estado estacionario individualmente,
lo que permite estudiar distintos tipos de transición económica, por ejemplo, la divergencia temporal
seguida por una aproximación económica y convergencia.

Además, el modelo de factores no lineal puede distinguir entre convergencia a un único estado
estacionario común a todas las economías, tal y como predice el modelo neoclásico de crecimiento, y
divergencia total. Por otra parte, la prueba de convergencia se puede aplicar de forma iterativa, con
el fin de identificar grupos de países convergentes dentro del panel, o bien, los denominados clubes
de convergencia. De acuerdo con la hipótesis de la existencia de ‘club de convergencia’ propuesta
originalmente por Azariadis (1996) y Galor (1996), el modelo de crecimiento neoclásico en realidad es
capaz de generar múltiples equilibrios; los países con estructuras económicas idénticas no tienen que
converger necesariamente a un mismo estado de crecimiento de equilibrio, sino que algunos países
ci pueden converger a un estado estable de alto nivel de rentas, mientras que otros pueden hacer frente
a una trampa de la pobreza. Por último, otra característica atractiva de este enfoque econométrico
es que también mide la velocidad y el grado de convergencia.

Este capítulo ofrece resultados relevantes sobre los aspectos económicos de la aproximación ex-
hibida por los nuevos miembros de la UE a la luz de los cambios institucionales y los procesos de ajuste
macroeconómicos experimentados en las últimas décadas. Varias conclusiones importantes surgen de
este análisis. Primero, no existe convergencia de la renta real per cápita en la UE. Este resultado es
robusto bajo cualquier horizonte temporal considerado. En cambio, se identifican subgrupos dentro
del panel que convergen hacia diferentes equilibrios de estado estacionario. En segundo lugar, los
vínculos regionales parecen jugar un papel significativo en la determinación de la formación de clubes
de convergencia. En tercer lugar, los países de la eurozona pertenecen a subgrupos distintos, por
lo tanto la agrupación no está necesariamente relacionada con la pertenencia a la UEM. En cuarto
lugar, hay una clara separación entre los PECO y los antiguos miembros de la UE en el largo plazo,
lo que sugiere que, a pesar de que los PECO han exhibido un mayor crecimiento de la renta real que
la media de la UE durante los últimos 40 años, esto no ha sido suficiente para eliminar las diferencias
en las rentas reales per cápita entre los países. Por último, la evidencia empírica destaca un retroceso
gradual de los países mediterráneos, lo que se ha traducido en una división a lo largo de la dimensión
Sur-Este vs. Norte-Oeste a mediados de los años noventa.

En resumen, el fracaso de la convergencia dentro de la UE transmite el mensaje clave de que la
hipótesis de una Europa "a varias velocidades" (Alesina y Grilli, 1993) prevalece casi treinta años
después de la ampliación del Mediterráneo y una década después de la ampliación del Este. Los resultados documentados en este artículo enfatizan la falta de reformas estructurales que mejorarian el crecimiento económico en los países de la UE, lo que representa una amenaza para el logro de la convergencia real en el futuro próximo. Por otra parte, a pesar del hecho de que las economías de los PECO pasaron por cambios profundos a partir de principios de los noventa, lo que indica un cierto grado de convergencia hacia el Oeste, el momento y el ritmo de la integración económica parece ser crucial, ya que la integración prematura puede limitar la senda de crecimiento de una economía debido a su punto de partida potencialmente inferior. Por lo tanto, a la luz de la nueva ampliación de la UE, las autoridades deben tener en cuenta las diferencias persistentes entre las economías europeas, que también puede facilitar la gobernanza económica y la coordinación de la política internacional en el futuro.

La economía mundial no está en buena forma. Han pasado ocho años desde el inicio de la Gran Recesión en diciembre de 2007, sin embargo, las consecuencias de la crisis seguirán persiguiéndonos hoy en día. El fin de la recesión fue oficialmente declarado en los EE.UU. en 2009, sin embargo, no se ha hecho prácticamente ningún progreso que permita alcanzar el potencial económico que el país tuvo antes de 2007. El crecimiento económico ha promediado menos de 2.5 por ciento, mientras que la inversión privada se ha estancado durante los últimos cinco años. El decepcionante rendimiento económico ha llevado a los economistas a volver a evaluar la hipótesis de "estancamiento secular", según la cual las limitaciones estructurales de la economía hacen que la demanda agregada adecuada y el crecimiento sostenible sean difíciles de lograr (por ejemplo, Summers, 2015).

Mientras tanto, uno de los mayores poderes de la economía mundial, la Unión Europea, sigue estando al borde del colapso. El crecimiento es anémico, y la desigualdad socio-económica va aumentando. Algunos aspectos destacados de los retos a los que los políticos se enfrentan hoy en día incluyen: el desempleo que sigue siendo alto en muchos países europeos, con tasas en España y Grecia por encima del doble de la media de la UE y la situación es aún peor cuando se trata de los jóvenes; los tipos de interés oficiales del Banco Central Europeo se han reducido hasta su límite inferior, pero ha sido insuficiente para compensar la caída de la demanda debido la disminución de la riqueza real y financiera y a las medidas de austeridad fiscal implementadas en varios países. Mientras escribe estas líneas, los miembros de la UE están haciendo los preparativos para una posible salida de Grecia de la zona euro. Además, tras las elecciones generales de 2015 en el Reino Unido, el reelegido primer ministro, David Cameron reiteró su compromiso de celebrar un referéndum sobre la permanencia o
salida de Gran Bretaña de la Unión Europea en 2017. Por último, se ha confirmado que los países de Europa Central y Oriental no han logrado cerrar la brecha que les separa del nivel de renta de la mitad más rica del continente. Encontrar la manera de superar estos problemas sigue siendo una tarea clave para los economistas en el futuro, y espero que mi tesis contribuya al menos en una pequeña parte de este esfuerzo.
Introduction

The financial crisis that started in the United States in 2007 has spread quickly to many advanced and emerging economies and transformed into the most severe global financial downturn since the Great Depression. The spillovers from financial markets to the real economy have been particularly large, with almost all advanced countries in recession for several quarters. These developments have raised a number of important questions about the linkages between the financial sector and economic fluctuations as well as the effectiveness of fiscal, monetary, and macro-prudential policies in such context. An emerging literature, exemplified by the work of Jermann and Quadrini (2012), demonstrates that financial shocks play a crucial role in generating business cycle movements, especially through the demand of labor. In addition, Borio (2014) and Aikman, Haldane and Nelson (2014) argue that financial frictions give rise to financial cycles distinct from the business cycle, characterized by lower frequency and greater amplitude. Ignoring these features can undermine the power of policymakers’ decisions, yet, even when considered, conventional policies may not be enough to stimulate the economy. For instance, some countries can use traditional monetary policy to affect the financial cycle, but for others, such as those in a liquidity trap, this option is not available. Others may have high debt and less room to conduct countercyclical fiscal policy. Besides, the recent experience of the European Union member states has shown that the success of a common policy framework depends largely on the degree of economic convergence. In fact, the unusually slow recovery from the latest recession suggests that structural diversity and economic divergence can endanger the “one size fits all” policy approach advocated by the proponents of the politico-economic union.

Motivated by new challenges posed by the financial crisis of 2007-2008, the purpose of my dissertation is to contribute to the field of empirical macroeconomics from an applied econometric perspective. The thesis consists of three independent essays that offer important implications for the design of optimal policies to mitigate the adverse effects of economic downturns, and to reduce their likelihood
in the future. The first two articles focus on two key aspects of macro-financial linkages in industrialized countries. Chapter 1 investigates the relationship between financial frictions and labor market performance. In particular, I explore how private credit contractions affect unemployment fluctuations along three dimensions, namely, the severity of the decline in credit, the financial leverage of an economy prior to the contractionary episode, and the flexibility of labor market institutions. Chapter 2 analyzes the differential impact of fiscal policies across the credit cycle. Based on the conjecture that fiscal multipliers depend critically on the financial environment, I examine how the effects of changes in government spending vary according to the state of credit markets, being expansionary or contractionary. Finally, the growing instability within the European Union and the uncertainty of the common currency in recent years has made it clear that, in highly integrated countries, economic convergence constitutes a prerequisite for common structural and monetary policies. Hence, starting from the premise that closer economic integration between countries may lead to increased real income per capita convergence, Chapter 3 seeks to understand the evolution of macroeconomic convergence in the European Union over the last forty years.

The world economy is not in good shape. Eight years have passed since the onset of the Great Recession in December 2007, yet the consequences of the crisis continue to haunt us today. The recession was declared to be officially over in the U.S. in 2009, however, there has been made almost no progress catching up to the country’s economic potential before 2007. Economic growth has averaged less than 2.5 percent, whereas private investment has been stagnant during the last five years. The disappointing performance led economists to reassess the hypothesis of ‘secular stagnation’, according to which structural constraints in the economy make adequate aggregate demand and sustained growth difficult to achieve (e.g., Summers, 2015). In the meantime, one of the greatest powers of the global economy, the European Union is still on the verge of collapse. Growth is anemic at best, and socio-economic inequality is on the rise. Some notable highlights of the challenges that policymakers are facing today include the followings. Unemployment remains high in many European countries, with unemployment rates in Spain and Greece being more than double that of the EU average. The situation is even worse when it comes to youth joblessness. The European Central Bank’s key policy rates have been reduced close to their zero lower bound, but it has been insufficient to offset the fall in demand due to a large decrease in real and financial wealth as well as fiscal austerity measures in several countries. At the time of writing, the EU members are making preparations for a possible Greek exit from the eurozone. In addition, following the 2015 general
election in the United Kingdom, the re-elected Prime Minister David Cameron reiterated an earlier commitment to hold a referendum on Britain’s membership of the European Union in 2017. Finally, it is now confirmed that the countries of Central and Eastern Europe have failed to bridge the income gap with the richer half of the continent. Finding ways to overcome these problems remains a key task for economists in the future, and I hope that my dissertation contributes in at least a small part to this effort.
Credit contractions and unemployment

1.1 Introduction

The most recent financial crisis has severely deteriorated labor market perspectives across the globe. It is estimated that nearly 202 million people, of which, 74.5 million young – aged 15-24 – were unemployed in 2013 worldwide, an increase of about 31.8 million – including 4.6 million young people – since the onset of the downturn in 2007 (ILO, 2014). OECD economies exhibited a massive increase of 15.2 million in total unemployment and 2.6 million in youth unemployment during the same period. Remarkably, youth unemployment has become one of the most urgent issues to deal with, characterized by a substantial rise and slow recovery (Verick, 2009; Bell and Blanchflower, 2011). The topic is of great importance, mainly due to the broader consequences of unemployment that policymakers should care about. Rising unemployment may lead to scarring effects – i.e., negative long-term effects on future labor market prospects –, social and political unrest, and growing inequality in the long run (Matsumoto, Hengge and Islam, 2012).

This chapter investigates empirically the relationship between credit market frictions and unemployment. The Great Recession that started in 2007 has led to renewed interest in the potential linkages between the financial sector and labor market outcomes, and there is compelling evidence that frictions underlying financial crises derive primarily – although not exclusively – from imperfections in the credit markets (Schularick and Taylor, 2012). Related contributions suggest that disruptions in the financial sector have a sizable effect on business cycle fluctuations (e.g., Gilchrist and Zakrajsek, 2012; Meeks, 2012), especially through the demand of labor (Jermann and Quadrini, 2012). In this regard, focusing on credit market frictions as a potential source of unemployment fluctuations is motivated by the transmission mechanism, according to which perturbations in the financial markets propagate directly to the real economy (see, e.g., Quadrini, 2011; Jermann and Quadrini, 2012; Kiyotaki and Moore, 2012). Since such disturbances affect the firms’ ability to

\footnote{Such disruptions may arise from the tightening of collateral or credit constraints, heightened uncertainty, reduced risk-bearing capacity of the financial intermediaries, or informational asymmetries.}
borrow, credit tightening can lead to increases in unemployment by cutting new investment and vacancies.

Hence, the goal of this study is to offer novel insights on the empirical relevance of private credit contractions for unemployment dynamics, using a panel of 20 OECD countries spanning the period 1980-2013. In particular, the main contribution lies in investigating the impact of credit downturns along three dimensions. First of all, by providing a direct measure of the extent to which contractions in private credit affect total, youth, and long-term unemployment. Secondly, the article explores the hypothesis that credit contractions, which arise after highly leveraged credit expansions tend to be followed by more severe unemployment and slower recovery. This conjecture is supported by the idea that increased leverage raises the financial fragility of an economy due to excessive risk-taking and lower lending standards as private debt piles up.\(^2\) Thirdly, the role of labor market institutions is additionally considered, since the variation in the size of the impact across contractions may stem from differences in the flexibility of labor regulations.\(^3\)

The dynamic impact of private credit contractions on labor market performance is assessed by using a direct forecast approach proposed by Jordà (2005). Specifically, the average cumulated path of unemployment across the panel is calculated with local projections for the years following the start of a contractionary episode. Credit contractions in the 20 OECD economies are identified by employing the Bry and Boschan (1971) dating algorithm. The estimation of impulse response functions using local projections has several attractive features. It does not require the specification and estimation of the true multivariate system itself, therefore, local projection techniques – based on multi-step direct forecasts – are robust to the misspecification of the data generating process. In addition, the method can conveniently accommodate nonlinearities in the response function. This enables to obtain consistent estimates of the average response of unemployment to the onset of a credit contraction by a sequence of projections, without imposing dynamic restrictions or additional structure. Potential endogeneity concerns are addressed by performing a variety of sensitivity analyses, including the estimation of the impact of credit downturns that begin during GDP expansions.

The findings of the chapter suggest that disruptions in the credit market have a large and statistically significant impact on unemployment. According to the estimation results, credit market downturns account for between one-third and one-half of the overall increase in joblessness in the


\(^3\)A rich set of works focuses on the importance of labor market institutions in explaining differences in unemployment patterns (see, e.g., Blanchard and Wolfers, 2000; Nickell, Nunziata and Ochel, 2005; Feldmann, 2009).
sample in the four years following the onset of a contraction. The peak effect occurs, on average, two years after the beginning of the decline in credit, and it does not quite vanish after four years. A credit contraction in an OECD country is typically followed by a nearly 1% increase in total unemployment at the peak. The impact on young workers is even more pronounced, increasing the rate of youth unemployment by over 2.4%. Lasting effects of a credit downturn on long-term unemployment indicate a high degree of persistence and sluggish recovery. In addition, severe credit busts are coupled with greater rise in unemployment rates than milder credit contractions, with differences amounting to 2% in the medium term. Moreover, the evidence presented here shows that credit downturns following expansions with high financial leverage – as opposed to low financial leverage – trigger, on average, up to five times greater increases in joblessness. Finally, the severity of the impact depends heavily on the flexibility of labor market institutions. Credit contractions in economies with more rigid labor regulations result in substantially higher unemployment, especially among the young.

The remainder of the chapter is organized as follows. Section 1.2 reviews the literature on the sources of labor market fluctuations, with a particular focus on the relationship between financial frictions and unemployment. Section 1.3 introduces the data and presents some preliminary analyses. Section 1.4 details the methodological framework and describes the results. Section 1.5 provides robustness checks for the empirical estimation, and finally, Section 1.6 concludes.

### 1.2 Related literature

This study relates to three strands of literature. Firstly, it links to the dominant stream of pre-crisis research that explores the role of labor market institutions in accounting for differences in the evolution of unemployment. Empirical evidence suggests that unemployment dynamics largely depends on the flexibility of these institutions, with heavier regulation of labor associated with lower labor force participation and higher unemployment (Scarpetta, 1996; Nickell, 1997; Blanchard and Wolfers, 2000; Botero, Djankov, Porta, Lopez-de Silanes and Shleifer, 2004; Nickell et al., 2005; Feldmann, 2009). Moreover, a recent article by Kawaguchi and Murao (2012) shows that labor market regulations affect age-specific cohorts differently, with stricter firing restrictions increasing the effect of adverse macroeconomic shocks on youth unemployment rates. The current work contributes to this field of studies by examining how labor market institutions amplify the impact of credit contractions on unemployment.

Secondly, the chapter relates to a growing literature that investigates the impact of financial crises on labor market performance. These articles unanimously conclude that the aftermath of banking
crises is associated with deep and lasting effects on unemployment, exacerbating the negative impact that recessions bring about (Reinhart and Rogoff, 2009a; Boeri et al., 2012; Calvo, Coricelli and Ottonello, 2012; Bernal-Verdugo, Furceri and Guillaume, 2013). In addition, a handful of studies argue that highly leveraged firms – that are more dependent on finance – are more vulnerable during financial recessions. For instance, Pagano and Pica (2012) and Boeri et al. (2012, 2013) show using industry- and sector-level data that in financial crises, employment growth suffers disproportionately more in economies in which firms rely more heavily on external finance. The present work lends further support to their evidence by highlighting the importance of excessive leverage prior to a contraction in credit for the subsequent changes in unemployment rates.

Finally, the study connects to a large body of papers that focus on the relationship between financial markets and the real economy. Besides analyzing the effects of financial downturns in general, the years following the start of the latest crisis have witnessed a burgeoning of works on the driving forces behind such events. Claessens, Kose and Terrones (2009, 2012) and Mendoza and Terrones (2012) emphasize the importance of credit and housing markets in shaping business cycle fluctuations. A series of recent papers demonstrate that financial crises can be regarded as credit booms gone bust (see Jordà, Schularick and Taylor, 2011; Taylor, 2012a,b; Schularick and Taylor, 2012; Jordà, Schularick and Taylor, 2013a). In a historical analysis, these studies provide statistical evidence that financial crises in advanced economies originate strictly from developments in the private credit markets, and there is no systematic correlation with either preceding inflation rates, current account deficits, or growth in public debt levels. Moreover, Jordà et al. (2013b) show that the credit intensity of an expansion preceding the onset of a crisis is closely associated with the severity of the recession. In sum, these articles corroborate the finding that private credit is the single reliable predictor of financial crises. Yet, linkages between credit markets and unemployment dynamics have received less attention in the literature.

Related works are mainly based on the seminal papers by Bernanke and Gertler (1989), Bernanke, Gertler and Gilchrist (1996), Bernanke, Gertler and Gilchrist (1999) and Kiyotaki and Moore (1997),

\footnotetext{4}{In an earlier paper, Sharpe (1994) documents that highly leveraged firms experience greater variation in employment over the business cycle. For a thorough discussion of the role of credit booms for macroeconomic fluctuations, see Hume and Sentance (2009).}

\footnotetext{5}{A number of earlier studies have already established a strong relationship between the financial system – endogenous credit booms in particular – and economic instability (see, e.g., Kindleberger, 1978; Eichengreen and Mitchener, 2003). In addition, the seminal work of Reinhart and Rogoff (2009b) provides a comprehensive analysis on financial fallouts throughout history, and further supports these findings.}

\footnotetext{6}{Previous papers that examine rapid credit growth prior to financial crises in emerging market economies include McKinnon and Pill (1997) and Reinhart and Kaminsky (1999). A more recent work by Mendoza and Terrones (2012) investigates credit booms in 61 emerging and industrial countries over the 1960-2010 period, and finds that large credit expansions are often followed by financial crises.}
which explain how financial market imperfections amplify and propagate shocks – that originate in other sectors – to the real economy through an accelerator mechanism. The underlying research suggests that endogenous developments in the financial sector, such as credit market imperfections, can significantly deteriorate labor market performance through restricting investment and firm-entry, i.e., job creation (see, e.g., Acemoglu, 2001; Wasmer and Weil, 2004; Dromel, Kolakez and Lehmann, 2010). Acemoglu (2001) reveals that differences in the European and U.S. credit markets due to financial system regulations have led to disparities in long-run unemployment dynamics. Wasmer and Weil (2004), and more recently, Petrosky-Nadeau and Wasmer (2013) analyze the financial accelerator that results from the complementarity between search frictions in credit and labor markets. They show that credit imperfections aggravate the negative effect of labor market frictions on unemployment, but intense competition in the credit market enlarges the favorable effect of labor deregulation. Additionally, Petrosky-Nadeau (2014) introduces vacancy costs that require external funding, and finds that such frictions can generate sufficient propagation of productivity shocks in a search-and-matching framework.

Another credit channel relies on the hypothesis that shocks, which arise in the financial sector can translate directly to the real economy. Quadrini (2011) proposes a possible mechanism by which exogenous forces can emerge in the financial markets, based on asset bubbles. Such bubbles can generate asset price movements that affect the business cycle through the tightening of the borrowing constraint. In addition, Jermann and Quadrini (2012) argue that financial shocks are transmitted to the real economy through the demand of labor. These authors develop a model with debt and equity financing to explore the macroeconomic effects of disruptions in the financial sector and demonstrate that credit shocks have played an important role in capturing the dynamics of labor and output in the U.S. economy over the last decades. Finally, Bentolila, Jansen, Jiménez and Ruano (2013) and Chodorow-Reich (2014) analyze the impact of large credit supply shocks on firm-level employment in Spain and the U.S., respectively. Both articles exploit differences in lender health at the onset of the Great Recession, and show that unanticipated reductions in bank lending have a sizable effect on employment outcomes.

Despite the increasing number of studies investigating the relationship between financial frictions

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7For an empirical contribution to the theory, see Gatti, Rault and Vaubourg (2012).
9Monacelli, Quadrini and Trigari (2011) propose and alternative transmission mechanism to capture the effect of financial disturbances on unemployment fluctuations. They embed financial frictions in a search-and-matching model with wage bargaining, where credit constraints affect the bargaining of wages.
and labor market performance, empirical works addressing the topic at the aggregate level are limited. Hence, this chapter contributes to the existing literature by providing new evidence on the relationship between private credit contractions and unemployment fluctuations in a time series cross-country analysis.

1.3 Data and preliminary analysis

1.3.1 Data

The study makes use of a dataset that covers 20 OECD economies spanning from 1980 to 2013. The choice of the sample period is justified by two reasons. First, as documented by Schularick and Taylor (2012), credit markets took time to recover in many developed countries after the collapse during World War II and grew very rapidly starting from the post-Bretton Woods era. Second, the current work innovates with respect to related articles by encompassing economic fluctuations following the most recent financial crisis.

The core data include annual series of output, unemployment, private credit, and a composite measure of labor market flexibility. Series of nominal GDP and total unemployment rate are taken from the World Economic Outlook (WEO) database, while youth and long-term unemployment rates are from the OECD, Eurostat, and the World Bank’s World Development Indicators (WDI) database. The financial variable considered is credit to the non-financial private sector by domestic banks, and a balanced panel is obtained from a relatively new database constructed by the Bank of International Settlements (BIS). Private credit series are converted into real terms using consumer price indices (CPI) from the WDI database. Following Feldmann (2009), labor market flexibility is proxied by a composite indicator taken from the Economic Freedom of the World (EFW) database (Gwartney, Lawson and Hall, 2013). The EFW component ‘labor market regulations’ measures labor market flexibility based on six sub-indicators: minimum wages; hiring and firing regulations; centralized collective bargaining; hours regulations; mandated cost of worker dismissal; and military conscription. The composite index as well as each sub-component is scaled to take values between

---

10 The countries are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

11 Youth unemployment is defined as the share of the labor force aged 15-24 without work but available for and seeking employment. Long-term unemployment refers to the number of people with continuous periods of unemployment extending for a year or longer, expressed as a percentage of the total unemployed.

12 One advantage of the data provided by the BIS is that the series are adjusted for breaks, which result from the combination of the various sources and methodological frameworks. Annual series are derived from quarterly data.
1.3. Data and preliminary analysis

0 and 10, with higher values indicating more flexible labor market.\textsuperscript{13} In addition, the study uses an extensive set of other variables in the formal empirical analysis. A complete list of variables and their sources is provided in Appendix A.

1.3.2 Descriptive statistics

Figure 1.1 displays the evolution of private credit together with total unemployment rate for the panel average over the last 33 years. It is evident from the figure that declining credit growth in a typical OECD country tends to be followed by an increase in the rate of unemployment. Notice that such negative relationship between the two time series prevailed already before the most recent financial turmoil, therefore pointing toward the existence of an important regularity between private credit contractions and joblessness.

The upper panel of Table 1.1 reports summary statistics for the three measures of unemployment, private credit, private credit to GDP, and the composite index of labor market flexibility. One thing to notice is the disproportionately high ratio of average youth to overall unemployment that stands at 2.1. This suggests that youth unemployment has been a problem in many countries for several decades, and raises the issue of the negative long-term consequences for the young as well as for the society as a whole. Youth unemployment in Southern European countries like Greece, Italy, and Spain is of particular concern, where it accounts for up to one-half of the labor force aged 15-24. Private credit is a variable trending generally upward over time, with mean growth of 4\% per year. In financial recessions however, the trend is muted, exhibiting even negative growth rates in some occasions. This also applies to the ratio of private credit to GDP, a commonly used measure to capture the financial leverage of an economy.

The lower panel of Table 1.1 presents the correlation matrix for the key variables of interest.\textsuperscript{14} All cross-correlation coefficients are significant at 1\%. The outcomes are suggestive of a negative contemporaneous correlation among private credit and unemployment, which is even stronger if the lagged values of credit are considered. Hence, fluctuations in private credit seem to lead unemployment. Moreover, there is a significantly negative association between labor market regulations and unemployment, which appears to be more pronounced for the long-term unemployment series. This implies that in OECD countries with more flexible labor markets, long-term unemployment is lower, that is, less people suffer a year or longer period of joblessness, on average. In addition, young peo-

\textsuperscript{13}See Feldmann (2009) for a comprehensive discussion on the conveniences of employing the EFW database.

\textsuperscript{14}Private credit and private credit to GDP are transformed here by taking the natural logarithm and applying the Hodrick and Prescott (1997) filter, with the smoothing parameter set to 100.
Figure 1.1: Private credit and unemployment between 1980 and 2013

Note: The sample period is 1980-2013 and cross-country averages are shown for 20 OECD economies. Annual change in private credit (bars, left axis, %) is plotted against total unemployment rate (solid line, right axis, %).

People are affected more by the type of labor market institutions, most likely due to hiring and firing restrictions that insulate rather the older workers (Kawaguchi and Murao, 2012).

1.3.3 Identification of credit contractions

This subsection presents the identification of credit contractions and summarizes their cyclical properties along three dimensions, namely, the severity, financial leverage, and the flexibility of labor market institutions. The dating method used to identify turning points (i.e., peaks and troughs) in the credit cycles relies on the seminal papers by Bry and Boschan (1971) and Harding and Pagan (2002), which analyze the business cycle characteristics of various macroeconomic variables.\footnote{Other works that employ this approach in order to describe financial cycles include Pagan and Sossounov (2003), Drehmann, Borio and Tsatsaronis (2012) and Claessens et al. (2009, 2012).}

The Bry and Boschan (1971) algorithm searches for local minima (troughs) and maxima (peaks) in the panel based on a set of criteria over a given period of time. In line with this approach, a credit cycle is defined here as a sequence of expansionary and contractionary phases in the annual series of (log-levels of) real private credit, where an expansionary phase lasts from trough to peak, whilst a contractionary phase lasts from peak to trough. Thus, each peak in the private credit series
Table 1.1: Descriptive statistics

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Unemployment</td>
<td>7.5</td>
<td>3.3</td>
<td>0.2</td>
<td>27.3</td>
</tr>
<tr>
<td>Youth Unemployment</td>
<td>15.8</td>
<td>7.8</td>
<td>3.2</td>
<td>58.3</td>
</tr>
<tr>
<td>Long-term Unemployment</td>
<td>33.3</td>
<td>15.2</td>
<td>4.3</td>
<td>75.6</td>
</tr>
<tr>
<td>Private Credit Growth</td>
<td>4.0</td>
<td>2.1</td>
<td>-18.8</td>
<td>25.9</td>
</tr>
<tr>
<td>Private Credit to GDP</td>
<td>80.9</td>
<td>12.2</td>
<td>25.3</td>
<td>205.3</td>
</tr>
<tr>
<td>Labor Market Index</td>
<td>5.9</td>
<td>1.7</td>
<td>2.6</td>
<td>9.3</td>
</tr>
</tbody>
</table>

Cross-correlation

<table>
<thead>
<tr>
<th></th>
<th>Total U</th>
<th>Youth U</th>
<th>Long-term U</th>
<th>Private Credit</th>
<th>Credit to GDP</th>
<th>Labor Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Unemployment</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Youth Unemployment</td>
<td>0.87</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long-term Unemployment</td>
<td>0.52</td>
<td>0.56</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private Credit</td>
<td>-0.28</td>
<td>-0.29</td>
<td>-0.42</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private Credit to GDP</td>
<td>-0.16</td>
<td>-0.19</td>
<td>-0.14</td>
<td>0.42</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Labor Market Index</td>
<td>-0.21</td>
<td>-0.27</td>
<td>-0.39</td>
<td>0.42</td>
<td>0.24</td>
<td>1</td>
</tr>
</tbody>
</table>

Note: Summary statistics for labor market variables refer to rates of total (Total U), youth (Youth U), and long-term (Long-term U) unemployment. Private credit growth is annual change of credit to the non-financial private sector by domestic banks, and private credit to GDP measures the financial leverage of an economy. Labor Market Index (Labor Index) refers to a composite indicator of labor market flexibility taken from the Economic Freedom of the World database, scaled to take values between 0 and 10, with higher values indicating a more flexible labor market. All outcomes in the correlation matrix are significant at 1%.

(hereafter, credit peak) refers to the start of a credit contraction.

In what follows, the cyclical measures examined are amplitude, duration, and slope. The amplitude of an expansionary phase is defined as trough-to-peak change in private credit, while the amplitude of a contractionary phase measures the change in credit from peak to trough. The duration of an expansion is the number of years between a trough and the following peak. Similarly, the duration of a contraction is the number of years from a peak to the subsequent trough. Finally, the slope is annual growth rate of private credit, given by the ratio of amplitude over duration for each phase.

Since the main focus of the article is to assess the impact of credit downturns on unemployment, cyclical properties are obtained only for the contractionary phase, for both private credit and unemployment (Table 1.2). In addition, contractionary episodes are sorted into two groups, depending on the severity of the fall in private credit (top panel). Following Claessens et al. (2009), a peak-to-trough credit contraction is classified as severe if the decline in private credit falls within the top
Table 1.2: Cyclical characteristics of private credit contractions and unemployment

<table>
<thead>
<tr>
<th>Type of contraction</th>
<th>Private Credit</th>
<th>Total U</th>
<th>Youth U</th>
<th>Long-term U</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amplitude</td>
<td>Duration</td>
<td>Slope</td>
<td>Amplitude</td>
</tr>
<tr>
<td>All</td>
<td>-9.11</td>
<td>2.81</td>
<td>-2.92</td>
<td>2.11</td>
</tr>
<tr>
<td>Severe</td>
<td>-21.88</td>
<td>4.92</td>
<td>-5.02</td>
<td>4.40</td>
</tr>
<tr>
<td>Non-Severe</td>
<td>-4.86</td>
<td>2.10</td>
<td>-2.22</td>
<td>1.35</td>
</tr>
<tr>
<td>High Leverage</td>
<td>-11.68</td>
<td>2.85</td>
<td>-3.58</td>
<td>3.47</td>
</tr>
<tr>
<td>Low Leverage</td>
<td>-6.16</td>
<td>2.00</td>
<td>-2.56</td>
<td>0.91</td>
</tr>
<tr>
<td>Flexible labor</td>
<td>-8.09</td>
<td>2.32</td>
<td>-2.93</td>
<td>1.48</td>
</tr>
<tr>
<td>Rigid Labor</td>
<td>-10.06</td>
<td>3.26</td>
<td>-2.92</td>
<td>2.70</td>
</tr>
</tbody>
</table>

Note: The table shows the cyclical properties of private credit (Private Credit), total (Total U), youth (Youth U), and long-term (Long-term U) unemployment for credit contractions, for a sample of 20 OECD countries between 1980-2013. Amplitude is peak-to-trough change in real private credit (in percent) and unemployment rates (change in levels, in percentages). Duration refers to the number of years from peak to trough. Slope denotes the annual rate of change in private credit during a contraction (in percent). Severe credit contractions correspond to peak-to-trough declines in private credit that fall within the top quartile of all credit contractions. Credit contractions are classified as highly (low) leveraged if the excess rate of change per year in the private credit to GDP ratio during the preceding expansionary phase was above (below) its full sample mean. Credit contractions are characterized by flexible (rigid) labor market institutions if the composite indicator of labor market flexibility is above (below) the full sample historical mean at the onset of the contraction. All values are reported in means.

To complement the analysis, this study examines how the decline in unemployment varies with the financial leverage of an economy. The build-up of leverage is potentially linked to the severity of a downturn through increased systemic fragility due to greater risk-taking (see, e.g., Claessens...
and Kose, 2013; Gorton and Ordonez, 2014). Consequently, economies in which firms depend more on external finance may be hit more heavily when a credit contraction occurs, as a subsequent deleveraging triggers larger cuts in hiring (Pagano and Pica, 2012; Boeri et al., 2012, 2013). An excess credit variable is thus constructed in the spirit of Jordà et al. (2013b), which refers to the rate of change per year in private credit to GDP, in deviation from its mean, in each expansionary episode preceding a credit peak. A following credit contraction is then defined as highly leveraged if the excess rate during the credit expansion was above its full sample mean. The middle panel of Table 1.2 reveals that the amplitude of highly leveraged private credit contractions is, on average, substantially larger than that of low leveraged contractions. More interestingly, increases in each measure of unemployment appear to be significantly greater during a contractionary phase with high financial leverage.

Finally, the bottom panel of Table 1.2 shows the cyclical features of credit contractions based on the labor market dimension. Credit downturns are characterized by flexible labor market institutions, if the composite measure of labor market flexibility in an OECD country was above the full sample historical mean at the beginning of the contraction, and by rigid labor institutions otherwise. It seems that contractionary phases with rigid labor markets are not only more severe and prolonged, but also display greater increases in unemployment rates on average (2.70% versus 1.48%). In addition, the climb in youth unemployment during such episodes (6.29%) is more than double the increase throughout credit contractions with flexible labor markets (2.77%), reflecting the adverse consequences of labor rigidities for young workers. All descriptive results are formally tested in the next section.

The Savings and Loan crisis of the 1980s and 1990s in the U.S. provides a good illustration of the cyclical characteristics of credit and unemployment. Figure 1.2 shows that the United States experienced a rapid expansion of credit starting from 1982, which peaked in 1989 after a slowdown in the preceding years. The following period between 1989 (credit peak) and 1993 (credit trough) is referred to as a contractionary episode, displaying a sharp decline in credit and rising unemployment. Credit fell by close to 22% in the four years from the peak to the subsequent trough, therefore the downturn is classified as severe. However, since the preceding credit expansion was low leveraged – due to high GDP growth at the same time –, and labor market institutions in the country were quite flexible at the beginning of the contraction, joblessness started to recover soon, already after three years. For this reason, the accumulated increase in unemployment rate during the credit downturn was somewhat below the mean across all contractionary phases (1.65% versus 2.11%) as opposed to
Figure 1.2: Turning points in the credit cycle and unemployment (United States, 1980-2000)

Note: Real private credit (log-levels, left axis) is plotted against total unemployment rate (right axis, %) for the United States between 1980 and 2000. The sample period corresponds to the Savings and Loan crisis of the 1980s and 1990s. The dashed line indicates the year of the credit peak, i.e., the beginning of the credit contraction.

the year before, when it peaked at 2.23 percentage points.

1.3.4 Credit growth and unemployment around contractions

Figure 1.3 offers a visual inspection of the dynamics of private credit and unemployment around credit contractions. Year-on-year changes in credit growth and changes in the rates of total, youth, and long-term unemployment are shown for 4 years before and 4 years after a credit peak (at period 0). Means of each series are plotted together with the upper and lower quartiles, to account for potential outliers in the sample. Private credit growth typically declines already ahead of a credit peak and decreases even more before it starts to recover (Figure 1.3/(a)). Furthermore, Figures 1.3/(b)-(d) suggest an association between the evolution of credit and unemployment. Slower credit growth one year before a peak is coupled with a rise in unemployment rates, which becomes sharper in the first year of a contractionary phase (Figure 1.3/(b)). Total unemployment climbs by 2.5 percentages four years after the beginning of a contraction, and the increase is substantially larger for youth unemployment (Figure 1.3/(c)). Long-term unemployment rises notably one year after a credit peak
Figure 1.3: Dynamics of private credit and unemployment around credit contractions

![Figure 1.3](image)

Note: Solid lines indicate means of (a) private credit growth (%) and rates of (b)-(d) total, youth, and long-term unemployment (%) along with the top and bottom quartiles (dashed lines) for 4 years before and 4 years after a credit peak. Period 0 denotes the year of the credit peak, i.e., the beginning of a credit contraction. Change in private credit growth is in percents per year, and change in unemployment rates is in levels, in percentages.

While private credit recovers, on average, four years after the start of a downturn, unemployment rates still remain well above their pre-peak level. Thus, the observed labor market patterns do not only hint at high persistence, but reveal that credit contractions are likely to be followed by jobless recoveries.\(^\text{17}\)

1.4 Methodology and results

1.4.1 Empirical framework

In the econometric investigation, the main focus is directed at the path of unemployment after a private credit expansion has reached its peak, i.e., after which a credit contraction begins. Impulse...
response functions (IRFs) are obtained using local projections, a single-equation approach introduced by Jordà (2005). The central idea consists in calculating the impact of credit contractions on unemployment by estimating projections at each period of interest. Since the onset of a credit downturn is considered as a binary treatment, the study strictly follows Jordà et al. (2013b) in order to compute impulse responses using a least-squares dummy variable model.

To begin with, the average cumulated response of unemployment across countries and credit contractions \((C)\) for \(h = 1, 2, \ldots, H\) future horizons is defined as:

\[
CR(\Delta hU_{i,t}(p)+h, C) = E_{i,t(p)}(\Delta hU_{i,t(p)+h}|C_{i,t(p)} = 1, \Omega) - E_{i,t(p)}(\Delta hU_{i,t(p)+h}|C_{i,t(p)} = 0, \Omega), \quad h = 1, 2, \ldots, H, \tag{1.1}
\]

where \(U_{i,t(p)+h}\) denotes unemployment for each country \(i = 1, 2, \ldots, N\), and for every horizon \(h\) following a discrete treatment, and \(C_{i,t(p)}\) is a binary indicator that takes value 1 for a credit peak, and zero otherwise. The subscript \(t(p)\) refers to the period of the \(p^{th}\) credit peak in country \(i\), derived from the Bry and Boschan (1971) dating algorithm in Section 1.3.3. As noted before, the interest lies in analyzing the average change of unemployment following the onset of a credit contraction at \(t(p)\) to some distant period \(t(p) + h\) after the peak. Thus, a credit peak may be understood as a period in which a country’s credit expansion comes to an end – and a contractionary episode starts –, and Expression 1.1 measures the average treatment response of unemployment to contractions across the panel, conditional on a set of economic variables represented by \(\Omega\). Ideally, the estimation of Expression 1.1 would require a correctly specified model, yet, the average response for each horizon can be likewise approximated by a series of local projections. Specifically, the conditional path of the cumulated response of unemployment is obtained by estimating the following fixed effects panel regression for \(h = 1, 2, \ldots, H\) horizons:

\[
\Delta hU_{i,t+h} = \alpha_i^h + \sum_{j=0}^1 \beta_j^h \Delta U_{i,t-j} + \gamma^h C_{i,t} + \delta^h L_{i,t} + \sum_{j=0}^1 \theta_j^h X_{i,t-j} + \epsilon_{i,t}^h, \tag{1.2}
\]

where \(\Delta hU_{i,t+h}\) is the change of unemployment from time \(t\) to each future period \(t+h\), country fixed effects denoted by \(\alpha_i\) capture unobserved country-specific heterogeneity, and the lagged changes of \(U_{i,t}\) control for the persistence of unemployment. The coefficient \(\gamma^h\) measures the effect of the onset of a credit contraction on the changes in unemployment for each future period \(t+h\). \(L_{i,t}\) is the composite index of labor market flexibility, and \(X_{i,t-j}\) is a vector of contemporaneous and 1-year-lagged values of the explanatory variables that potentially affect outcomes, including (1) GDP growth; (2) CPI
1.4. Methodology and results

inflation rate; (3) change in public debt to GDP; (4) change in trade openness; (5) population; and (6) output gap, which controls for the unemployment effects of business cycle fluctuations.\footnote{Output gap is annual real GDP detrended using the Hodrick and Prescott (1997) filter.}

The greatest benefit of using direct local analysis is that IRFs can be obtained without the specification and estimation of the underlying multivariate system, and therefore, local projection techniques are less prone to misspecification errors. Moreover, the method can easily accommodate nonlinearities in the response function, which may be impractical to model with assumptions about the global data generating process. To account for serial correlation induced in regressions for each future horizon, inference can be performed using heteroskedastic and autocorrelation robust standard errors. In addition, as lagged variables enter only as controls in the estimation equation, they are not used to derive the IRFs. Since the specification is not sensitive to the choice of the number of lags, impulse responses generated using local projections are stable. Finally, another appealing feature of the method is that the confidence bands related to the IRFs can be derived from the standard errors of the estimated coefficients of interest, and therefore, no bootstrapping techniques or Monte Carlo simulations are required. The reader is referred to Jordà (2005) for further details.

1.4.2 Estimation results

Estimated coefficients $\gamma_h$ for changes in unemployment are computed for four years following the onset of a credit contraction, and White-robust standard errors are applied to correct for potential heteroskedasticity.\footnote{For $h > 4$ horizons, several credit peaks surrounding the outbreak of the most recent global financial crisis would be omitted from the estimation.} Figure 1.4 displays impulse responses along with the 95% confidence bands for total, youth, and long-term unemployment. The results suggest that the impact of a private credit contraction on unemployment is large and statistically significant, increasing total and youth unemployment rates by nearly 1% and 2.4% respectively, after two years. In the four years following the onset of a contraction, credit downturns account for, on average, between one-third and one-half of the total rise in joblessness observed in the data.\footnote{Note that the cumulated path of unemployment estimated with local projections is directly comparable to the average unemployment rate across all contractions presented in Section 1.3.4.} Long-term unemployment increases starting from the second year, and the effects become significant from the third year on, pointing to the high degree of unemployment persistence. The increasing duration of involuntary joblessness can be explained by hysteresis effects operating through various mechanisms; for instance, jobless workers become both less attractive (Ball, 2009) and more discouraged (Krueger and Mueller, 2011) over time, as unemployment lasts longer. These findings are also in line with the existing concerns
that structural unemployment in many OECD countries has been shifted upwards following the most recent financial recession, and the increase could persist even when the economies recover (e.g., Guichard and Rusticelli, 2011). Estimation results are shown in Table 1.3.\footnote{The estimated coefficients of the 1-year-lagged explanatory variables are not shown here, but are available from the author.} The coefficients for the 1-period lagged change in unemployment are significant at each horizon, which reflects the persistence of the corresponding variable. The negative sign of the coefficient for the composite labor market index shows that more rigid labor regulations are associated with greater increases in unemployment. Such an inverse relationship is consistent with the empirical evidence for OECD
### Table 1.3: Estimation results

<table>
<thead>
<tr>
<th>Change in unemployment (relative to year 0)</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Period Lagged Change in Unemployment</td>
<td>0.319***</td>
<td>0.454***</td>
<td>0.418***</td>
<td>0.399**</td>
</tr>
<tr>
<td></td>
<td>(0.068)</td>
<td>(0.094)</td>
<td>(0.110)</td>
<td>(0.158)</td>
</tr>
<tr>
<td>2-Period Lagged Change in Unemployment</td>
<td>0.057</td>
<td>0.093</td>
<td>0.155</td>
<td>0.118</td>
</tr>
<tr>
<td></td>
<td>(0.047)</td>
<td>(0.082)</td>
<td>(0.122)</td>
<td>(0.148)</td>
</tr>
<tr>
<td>Credit Peak</td>
<td>0.473***</td>
<td>0.901***</td>
<td>0.821***</td>
<td>0.556</td>
</tr>
<tr>
<td></td>
<td>(0.134)</td>
<td>(0.199)</td>
<td>(0.261)</td>
<td>(0.351)</td>
</tr>
<tr>
<td>Labor Market Index</td>
<td>-0.087**</td>
<td>-0.189***</td>
<td>-0.222***</td>
<td>-0.128</td>
</tr>
<tr>
<td></td>
<td>(0.038)</td>
<td>(0.063)</td>
<td>(0.081)</td>
<td>(0.093)</td>
</tr>
<tr>
<td>GDP Growth</td>
<td>-0.062***</td>
<td>-0.096***</td>
<td>-0.084**</td>
<td>-0.058</td>
</tr>
<tr>
<td></td>
<td>(0.023)</td>
<td>(0.035)</td>
<td>(0.041)</td>
<td>(0.040)</td>
</tr>
<tr>
<td>Output Gap</td>
<td>0.056</td>
<td>0.275***</td>
<td>0.532***</td>
<td>0.738***</td>
</tr>
<tr>
<td></td>
<td>(0.040)</td>
<td>(0.056)</td>
<td>(0.070)</td>
<td>(0.093)</td>
</tr>
<tr>
<td>CPI Inflation</td>
<td>0.164***</td>
<td>0.300***</td>
<td>0.272***</td>
<td>0.194**</td>
</tr>
<tr>
<td></td>
<td>(0.028)</td>
<td>(0.051)</td>
<td>(0.072)</td>
<td>(0.083)</td>
</tr>
<tr>
<td>Change in Public Debt to GDP</td>
<td>0.014**</td>
<td>0.008</td>
<td>0.011</td>
<td>0.010</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
<td>(0.008)</td>
<td>(0.009)</td>
<td>(0.011)</td>
</tr>
<tr>
<td>Change in Trade Openness</td>
<td>0.004</td>
<td>-0.007</td>
<td>-0.008</td>
<td>-0.020</td>
</tr>
<tr>
<td></td>
<td>(0.007)</td>
<td>(0.010)</td>
<td>(0.014)</td>
<td>(0.017)</td>
</tr>
<tr>
<td>Population</td>
<td>0.000</td>
<td>0.001</td>
<td>0.002</td>
<td>0.003***</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>Number of Observations</td>
<td>620</td>
<td>600</td>
<td>580</td>
<td>560</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.55</td>
<td>0.59</td>
<td>0.62</td>
<td>0.63</td>
</tr>
<tr>
<td>Country Fixed Effects</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

Note: Estimated coefficients of the least-squares dummy variable model for 1-4 years after the onset of a private credit contraction (year 0). The dependent variable is change in total unemployment rate (in levels, in percentages). 

**, ***, and * represent statistical significance at 1, 5, and 10 percent levels, respectively. White-robust standard errors are in parentheses. All variables and their sources are defined in Table 1.4.

countries provided by Blanchard and Wolfers (2000) and Bassanini and Duval (2009). Estimates for real GDP growth, output gap, and inflation appear to be significant, with the expected signs. The results are qualitatively similar for youth and long-term unemployment (not reported here, available upon request).

Notice that the impact of a credit downturn on unemployment is obtained for the years after the occurrence of a credit peak, therefore the estimation is not likely to be subject to potential reverse causality. Yet, the evolution of private credit can be expected to be endogenous even after using a
Figure 1.5: The impact of credit contractions on unemployment during GDP expansions

![Figure 1.5](image)

Note: Impulse response function estimated by local projections for a panel of 20 OECD countries between 1980-2013. The solid line represents the average response of total unemployment rates to the onset of a private credit contraction at period 0 (in levels, in percentages). Only credit contractions that start during GDP expansions are considered. Dashed lines correspond to the 95% confidence band.

rich set of controls and their lags to absorb variation in the labor market outcomes. It is difficult to find a source of exogenous variation in the demand or supply of credit to borrowers in the context of a panel data analysis encompassing 20 economies over more than three decades. Nonetheless, a possible way to overcome this problem is by isolating the impact of a credit tightening for the specific phase of the business cycle when an economy is growing. Hence, to alleviate endogeneity concerns, the average path of unemployment is re-estimated following credit contractions that begin during GDP expansions. To this end, business cycle turning points are dated by the Bry and Boschan (1971) algorithm using real GDP per capita. A total of 12 credit peaks are identified during growth expansions over the years 1980 to 2013. Although this particular exercise provides relatively few observations, the estimates remain statistically meaningful, and consistent with the predictions of the baseline formulation for the full sample (see Figure 1.5).

The Savings and Loan crisis of the 1980s and 1990s presented in Section 1.3.3 is a good example of such an event. While the banking crisis produced the biggest collapse of U.S. financial institutions since the Great Depression of 1929, real GDP fell only a slight 0.1 percent between 1990 and 1991. In fact, the loss is reflected in the increase of the unemployment rate from 5.2% in 1989 to 7.5% in 1992, owing largely to related drops in market confidence and private investment activity (Akerlof and Shiller, 2009). Figure 1.6 illustrates the unfolding of the crisis that peaked in 1989, accompanied
Figure 1.6: The Savings and Loan crisis of the 1980s and 1990s in the U.S.

(a) Private credit and total unemployment

(b) Real GDP and total unemployment

Note: Log levels of (a) real private credit and (b) real GDP (left axis) are plotted against total unemployment rate (right axis, %) for the United States between 1980 and 2000. The dashed lines indicate the years of the peaks in (a) private credit and (b) real GDP.
by increasing unemployment rates (Figure 1.6/(a)), and a mild recession that followed a year after (Figure 1.6/(b)).

1.4.3 Unemployment and the severity of credit contractions

To capture the differential variation in joblessness due to the severity of a private credit downturn, unemployment paths following non-severe and severe credit contractions are examined next. For this purpose, the baseline specification given by Equation 1.2 is augmented to include a binary indicator for each type of contraction separately:

$$
\Delta h U_{i,t+h} = \alpha_i^h + \sum_{j=0}^1 \beta_{ij} \Delta U_{i,t-j} + \gamma_h^{NS} C_{i,t}^{NS} + \gamma_h^{S} C_{i,t}^{S} + \delta_h L_{i,t} + \sum_{j=0}^1 \theta_j^i X_{i,t-j} + \epsilon_{i,t},
$$

(1.3)

where $\gamma_h^{NS}$ and $\gamma_h^{S}$ measure the average response of unemployment to non-severe ($C_{i,t}^{NS} = 1$) and severe ($C_{i,t}^{S} = 1$) contractions, respectively. The impulse responses displayed in Figure 1.7 reveal the differential impact attributed to the severity of a credit downturn, which lends further support to the identification strategy. Severe credit busts are typically followed by substantial and long-lasting increases in unemployment, whereas the impact of other, non-severe contractions is moderate, with

Figure 1.7: The impact of credit contractions on unemployment: non-severe vs. severe contractions

Note: Impulse response functions estimated by local projections for a panel of 20 OECD countries between 1980-2013. Solid lines represent the average response of total unemployment rates to the onset of a non-severe (gray) and severe (black) private credit contraction (at period 0), separately (in levels, in percentages). The shaded area corresponds to the 95% confidence band of the impulse response to a non-severe private credit contraction. Severe credit contractions are defined as peak-to-trough declines in private credit that fall within the top quartile of all credit contractions.
unemployment recovering, on average, already after four years. The differences become statistically significant three years after the onset of a credit contraction, amounting to about 1% in period 3, and 2% in period 4. In addition, it is important to observe that while severe credit downturns last on average about 5 years (Table 1.2), unemployment rates seem to remain well above their pre-peak level when the decline in credit is already reversed.

1.4.4 Unemployment and financial leverage

The stylized facts provided in the preliminary analysis are indicative of the existence of an important relationship between the financial leverage of an economy before the onset of a contractionary phase and the subsequent changes in unemployment. Recall from Section 1.3.3 that a credit contraction is classified as highly leveraged if the excess rate of change per year in the private credit to GDP ratio during the expansion prior to the credit peak was above its full sample mean, and low leveraged otherwise. In order to validate the hypothesis through a formal statistical examination, cumulated responses to credit contractions with low and high financial leverage are estimated as follows:

$$
\Delta_h U_{i,t+h} = \alpha_h^i + \sum_{j=0}^{1} \beta_j^h \Delta U_{i,t-j} + \gamma_h^L C_{i,t}^L + \gamma_h^H C_{i,t}^H + \delta_h L_{i,t} + \sum_{j=0}^{1} \theta_j^i X_{i,t-j} + \epsilon_{i,t},
$$

(1.4)

where $\gamma_h^L$ and $\gamma_h^H$ measure the average response to credit contractions with low ($C_{i,t}^L = 1$) and high ($C_{i,t}^H = 1$) leverage, respectively. Impulse responses to both types of treatments are depicted in Figure 1.8. By dividing the sample based on the intensity of the credit build-up of the expansionary phase preceding each credit contraction, the resulting trajectories for unemployment are considerably different. It appears that a subsequent rise in total unemployment is up to five times greater when the expansion was highly leveraged. The labor markets recover relatively quickly, about three years after the beginning of a low leveraged credit contraction, while total unemployment persists and remains more than 1% above its pre-peak level following a contraction with high leverage, even after 4 years. Qualitatively similar predictions are obtained by Pagano and Pica (2012) and Boeri et al. (2012, 2013), which show that sectors that rely more heavily on external funding are more vulnerable to adverse financial shocks, characterized by greater job destruction rates than low leveraged sectors.

Besides analyzing the average response of unemployment to low and highly leveraged contractions, the marginal treatment responses due to a perturbation in the excess credit variable is considered. Following Jordà et al. (2013b), the binary indicator of each type of credit contraction is interacted with a term that measures the deviation of excess credit in the preceding low or highly leveraged
Figure 1.8: The impact of credit contractions on unemployment: low vs. high leverage

Note: Impulse response functions estimated by local projections for a panel of 20 OECD countries between 1980-2013. Solid lines represent the average response of total unemployment rates to the onset of a private credit contraction (at period 0) with low (gray) and high (black) financial leverage, separately (in levels, in percentages). The shaded area corresponds to the 95% confidence band of the impulse response to a low leveraged private credit contraction. Credit contractions are classified as highly (low) leveraged if the excess rate of change per year in the private credit to GDP ratio during the preceding expansionary phase was above (below) its full sample mean.

expansionary phase from its leverage-specific mean:

$$\Delta_h U_{i,t+h} = \alpha_h^i + \sum_{j=0}^{1} \beta_j^h \Delta U_{i,t-j} + \gamma^L_h C^L_{i,t} + \lambda^L_h (\phi_{i,t} - \bar{\phi}_L) C^L_{i,t}$$
$$+ \gamma^H_h C^H_{i,t} + \lambda^H_h (\phi_{i,t} - \bar{\phi}_H) C^H_{i,t} + \delta_h L_{i,t} + \sum_{j=0}^{1} \theta_j' X_{i,t-j} + \epsilon_{i,t}$$

(1.5)

where the continuous treatments $\phi_{i,t} - \bar{\phi}_L$ and $\phi_{i,t} - \bar{\phi}_H$ denote the excess rate of credit relative to the corresponding mean in the preceding low and highly leveraged expansion phases.\(^{22}\) The new coefficients of interest $\lambda^L_h$ and $\lambda^H_h$ measure the marginal effect of a pre-determined perturbation applied to the excess credit variable $\phi_{i,t}$ for each type of expansion separately. In this particular experiment, excess rates are perturbed by 1 standard deviation (s.d.) above their leverage-specific historical mean. Impulse responses along with the perturbed paths are shown in Figure 1.9. It seems that unemployment generally suffers more following an increment of 1 s.d. in the excess credit measure in highly leveraged contractions (black dashed line), whereas the treatment effect of the same

\(^{22}\)The excess leverage variable represented by $\phi_{i,t}$ refers to the excess rate of change in credit relative to GDP in the expansion phase preceding the onset of the credit contraction at time period $t$.\)
1.4. Methodology and results

Figure 1.9: The impact of credit contractions on unemployment: increased financial leverage

Note: Impulse response functions estimated by local projections for a panel of 20 OECD countries between 1980-2013. Solid lines represent the average response of total unemployment rates to the onset of a private credit contraction (at period 0) with low (gray) and high (black) financial leverage, separately (in levels, in percentages). Dashed lines correspond to trajectories when the excess rates of credit are perturbed by 1 standard deviation (s.d.) above their respective leverage-specific mean. Credit contractions are classified as highly (low) leveraged if the excess rate of change per year in the private credit to GDP ratio during the preceding expansionary phase was above (below) its full sample mean.

Perturbation in low leveraged credit downturns is rather subdued (gray dashed line). The marginal impact across contractions following highly leveraged credit expansions is initially negative, however, the coefficients turn positive and statistically significant after two years. A plausible explanation for such systematic relationship is that in highly leveraged episodes, a further increase in the rate of change in the credit-to-GDP ratio may initially have a favorable impact on unemployment, all else equal, and the subsequent deleveraging takes effect only from the second year on. Again, similar results are found for youth and long-term unemployment, not reported here.

1.4.5 The role of labor market institutions

Unemployment dynamics cannot be investigated in isolation from labor market institutions. While credit contractions can potentially explain much of the increase in joblessness, the average response of unemployment may vary due to differences in the flexibility of labor market regulations. Hence, this final subsection compares the impact of credit downturns on unemployment in episodes characterized
Figure 1.10: The impact of credit contractions on unemployment: flexible vs. rigid labor market institutions

Note: Impulse response functions estimated by local projections for a panel of 20 OECD countries between 1980-2013. Solid lines represent the average response of (a) total and (b) youth unemployment rates to the onset of a private credit contraction (at period 0) with flexible (gray) and rigid (black) labor market institutions, separately (in levels, in percentages). The shaded areas correspond to the 95% confidence bands of the impulse responses to a private credit contraction in flexible labor markets. Credit downturns are characterized by flexible (rigid) labor market institutions, if the composite indicator of labor market flexibility was above (below) the full sample historical mean at the beginning of the contraction.
1.5. Robustness checks

by flexible and rigid labor markets. Specifically, impulse response functions are calculated as follows:

$$\Delta h U_{i,t+h} = \alpha_h^i + \sum_{j=0}^{1} \beta_j^h \Delta U_{i,t-j} + \gamma_h^F C_{i,t}^F + \gamma_h^R C_{i,t}^R + \delta_h L_{i,t} + \sum_{j=0}^{1} \theta_{j}^F X_{i,t-j} + \epsilon_{i,t}^h,$$

where $\gamma_h^F$ and $\gamma_h^R$ capture the effect of credit contractions with flexible ($C_{i,t}^F = 1$) and rigid ($C_{i,t}^R = 1$) labor markets, respectively. Figure 1.10 presents the response of total and youth unemployment to credit contractions interacted with different levels of labor market regulations. The average path of unemployment peaks two years after the beginning of a downturn in countries with flexible labor market institutions. In contrast, unemployment rates in rigid labor markets increase sharply in the first three years and remain relatively high afterwards. Thus, labor market rigidities significantly amplify the impact of a fall in private credit. Besides, one should notice that the resulting trajectories differ substantially more for youth unemployment. This may be attributed to hiring and firing regulations that affect young people disproportionately harder (see, e.g., Kawaguchi and Murao, 2012). An in-depth analysis of the underlying reasons is, however, beyond the scope of this article, and would provide one fruitful avenue for future research.

1.5 Robustness checks

In order to assess the sensitivity of the regression outcomes, Equation 1.2 is first re-estimated by including an extensive set of controls that can potentially shape the evolution of unemployment over time. These variables are: (1) GDP per capita growth; (2) current account to GDP; (3) general government final consumption expenditure (in percent of GDP); (4) total investment (in percent of GDP); and (5) change in real exchange rates, to account for the competitiveness of the economies. The estimated coefficients for credit contractions using additional control variables remain significant in statistical terms, and the point estimates are nearly identical to those of the baseline specification. In addition, the outcomes are robust to the inclusion of time fixed effects. Impulse responses for each specification together with the baseline estimates are reported in Figure 1.11.

Another question that may arise is whether the findings are driven by the financial crisis of 2007-2008. To address this concern, the baseline estimation is repeated for the sub-period between 1980-2006. The sample falls to 33 contractionary episodes; nevertheless, the results obtained are robust to the exclusion of the Great Recession. Figure 1.12 shows that the cumulated response of unemployment to a credit downturn remains statistically significant and quantitatively unchanged, displaying an increase of about 1% at the peak. Overall, the coefficients are remarkably stable across
Figure 1.11: The impact of credit contractions on unemployment: alternative specifications

Note: Impulse response functions estimated by local projections for a panel of 20 OECD countries between 1980-2013. Solid lines represent the average response of total unemployment rates to the onset of a private credit contraction (at period 0), for three different specifications (in levels, in percentages): (i) baseline (black); (ii) baseline expanded with additional controls (dark gray); (iii) baseline with time fixed effects (light gray). Dashed lines correspond to the 95% confidence band of the baseline impulse response function.

the different specifications, confirming the adverse impact of credit contractions on unemployment.

1.6 Conclusion

This chapter investigates the linkages between credit markets and unemployment dynamics in a time series cross-country analysis. The study uses a dataset covering 20 OECD economies spanning from 1980 to 2013 and analyzes the effect of contractions in private credit on labor market performance. Specifically, the Bry and Boschan (1971) dating algorithm is applied to identify credit peaks, i.e., turning points in credit cycles to estimate the impact of credit contractions on unemployment fluctuations. Impulse responses of total, youth, and long-term unemployment are obtained using the local projection method introduced by Jordà (2005). In addition, the intensity of the countries’ financial leverage during the preceding expansion and the role of labor market institutions are also considered.

The results shed new light on the empirical relationship between private credit and unemployment, and a variety of robustness checks strengthen the findings. In particular, evidence in the article suggests that disturbances in the credit market affect both the level and persistence of unemployment, with more severe declines in credit followed by greater increases in joblessness. Regarding the estimates for youth unemployment, the impact is even more pronounced. Lasting effects of a
credit downturn on long-term unemployment point toward high persistence and sluggish recovery. To understand the quantitative significance of the impact, credit tightening accounts for, on average, between one-third and one-half of the increase in unemployment in the sample across four years after the onset of a contraction. Moreover, the results reveal that the credit build-up of an economy matters for the subsequent changes in joblessness. Excessive leverage during the credit expansion preceding a contractionary phase triggers, on average, relatively higher unemployment in the following downturn. Finally, the detrimental effect of credit contractions depends heavily on the flexibility of labor markets, with tighter regulations contributing to greater increases in unemployment.

The findings of this chapter highlight the empirical relevance of the credit transmission channel for joblessness, yet, further theoretical research is necessary for the better understanding of the fundamental mechanisms. In terms of practical implications, the evidence that credit contractions translate to the labor market suggests that policies directed to improved financial regulation and macro-prudential supervision are capable of mitigating the negative consequences that credit disruptions bring about. In addition, labor market policies should be targeted at preventing that the youth and long-term unemployed exit from the labor force, an existing concern in several OECD economies in the aftermath of the most recent global financial crisis.
### 1.7 Appendix A: List of variables

Table 1.4: Definition and sources of variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Variable definition</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private credit</td>
<td>Credit to the non-financial private sector by domestic banks, adjusted for breaks (in millions of national currency).</td>
<td>BIS</td>
</tr>
<tr>
<td>Total unemployment rate</td>
<td>Percentage of the total labor force that is currently unemployed.</td>
<td>WEO</td>
</tr>
<tr>
<td>Youth unemployment rate</td>
<td>Percentage of the total labor force ages 15-24 that is currently unemployed.</td>
<td>Eurostat, OECD, and WDI</td>
</tr>
<tr>
<td>Long-term unemployment rate</td>
<td>Number of people with continuous periods of unemployment extending for a year or longer, as a fraction of the total unemployment (in percentages).</td>
<td>Eurostat and WDI</td>
</tr>
<tr>
<td>Labor market regulations indicator</td>
<td>Composite measure of labor market flexibility. Scaled to take values between 0 and 10, with higher values indicating more flexible regulation.</td>
<td>EFW</td>
</tr>
<tr>
<td>Nominal GDP</td>
<td>Gross domestic product in current prices (in billions of local currency).</td>
<td>WEO</td>
</tr>
<tr>
<td>Real GDP</td>
<td>Gross domestic product per capita in constant prices (in 2005 US Dollars).</td>
<td>WDI</td>
</tr>
<tr>
<td>Consumer price index</td>
<td>Consumer prices, all items, index (2005 = 100).</td>
<td>WDI</td>
</tr>
<tr>
<td>Real exchange rate</td>
<td>Real effective exchange rates, index (2005 = 100).</td>
<td>WDI</td>
</tr>
<tr>
<td>Population</td>
<td>Total population (in thousands).</td>
<td>WDI</td>
</tr>
<tr>
<td>Public debt</td>
<td>Gross general government debt (in percent of GDP).</td>
<td>IMF and WEO</td>
</tr>
<tr>
<td>Trade openness</td>
<td>Sum of exports and imports of goods and services (in percent of GDP).</td>
<td>WDI</td>
</tr>
<tr>
<td>Total investment</td>
<td>Total value of the gross fixed capital formation (in percent of GDP).</td>
<td>WEO</td>
</tr>
<tr>
<td>Current account balance</td>
<td>Sum of net exports of goods and services, net primary income, and net secondary income (in percent of GDP).</td>
<td>WEO</td>
</tr>
<tr>
<td>Government consumption</td>
<td>General government final consumption expenditure (in percent of GDP).</td>
<td>WDI</td>
</tr>
</tbody>
</table>
## 1.8 Appendix B: Credit cycle peaks

Table 1.5: Credit cycle peaks

<table>
<thead>
<tr>
<th>Country</th>
<th>Credit peak</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>-</td>
</tr>
<tr>
<td>Austria</td>
<td>2002, 2010</td>
</tr>
<tr>
<td>Finland</td>
<td>1989</td>
</tr>
<tr>
<td>France</td>
<td>1991</td>
</tr>
<tr>
<td>Germany</td>
<td>2001</td>
</tr>
<tr>
<td>Italy</td>
<td>1993, 2011</td>
</tr>
<tr>
<td>Portugal</td>
<td>1982, 1988, 2010</td>
</tr>
<tr>
<td>Sweden</td>
<td>1990, 1992</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>1990, 2008, 2010</td>
</tr>
<tr>
<td>United States</td>
<td>1989, 2008</td>
</tr>
</tbody>
</table>

*Note:* The dates refer to peaks in the private credit series for each country in the sample (1980-2013). Credit peaks are identified using the Bry and Boschan (1971) dating algorithm.
2

Fiscal multipliers across the credit cycle

2.1 Introduction

Credit cycles are remarkable for two reasons. On the one hand, episodes of excessive private borrowing may lead to vulnerabilities in the financial system through looser lending standards, increased leverage, and systemic risks, which are often followed by severe economic downturns (Mendoza and Terrones, 2012; Schularick and Taylor, 2012). On the other, economic crises associated with credit crunches tend to be deeper and more prolonged than normal recessions (Reinhart and Rogoff, 2009a; Claessens et al., 2009; Jordà et al., 2013b). In addition, empirical evidence suggests that credit cycles have much lower frequency and greater amplitude than the traditional business cycles (Aikman et al., 2014). Interestingly, however, these salient features observed in industrialized economies for over a century now (Kindleberger, 1978; Schularick and Taylor, 2012) have been largely ignored until the global financial crisis of 2007-2008. Since then, a rich set of works have documented the role of finance in shaping macroeconomic dynamics (e.g., Brunnermeier, Eisenbach and Sannikov, 2012; Christiano, Motto and Rostagno, 2014, and references therein), which poses new challenges for policymakers going forward.\footnote{For a detailed discussion of the role and implications of the financial cycle for macroeconomics, see Borio (2014).}

A variety of measures have been proposed in recent years to deal with unhealthy credit booms and subsequent busts, such as more active monetary policy interventions and macroprudential policy instruments (see, for instance, Adrian and Shin, 2009; Mishkin, 2009; Bank of England, 2011; Gertler and Karadi, 2011; Borio and Zhu, 2012). Besides, given that the conventional monetary policies are typically ineffective in liquidity traps with interest rates at or near zero, fiscal tools have gained increasing attention in the aftermath of the latest economic crisis.\footnote{Several studies have looked at the quantitative effects of fiscal policies in liquidity traps and find that the government spending multiplier can be substantially large when the zero lower bound on the nominal interest rate binds (e.g., Woodford, 2011; Christiano, Eichenbaum and Rebelo, 2011; Eggertsson and Krugman, 2012). Against this view, Mertens and Ravn (2014) argue that a government spending stimulus is relatively ineffective when a liquidity trap is caused by a self-fulfilling state of low consumer confidence.} Nonetheless, despite the burgeoning of studies assessing the impact of fiscal policies, the effectiveness of government interventions
in addressing financial imbalances is still subject of much debate (e.g., Corsetti, Kuester, Meier and Müller, 2010; Mishkin, 2011; Kollmann, Roeger and in’t Veld, 2012; DeLong and Summers, 2012; Blanchard and Leigh, 2013). In fact, contrasting viewpoints regarding the magnitude of fiscal multipliers ever since the seminal work of Keynes (1936) emphasize the sensitivity of predictions, owing particularly to the assumptions about the economic context (see, e.g., Corsetti, Meier and Müller, 2012; Ilzetzki, Mendoza and Vegh, 2013).³ There is thus reason to believe that the size of fiscal multipliers depends critically on the state of financial markets, and failure to recognize that may undermine the power of public policy decisions.

Against this background, the purpose of this chapter is to offer important implications for the design of optimal fiscal policies, by analyzing the macroeconomic effects of changes in government spending across the credit cycle. In this regard, the current work also contributes to a growing literature that employs non-linear models to study the impact of fiscal policy in economic expansions and recessions, including Bachmann and Sims (2012), Auerbach and Gorodnichenko (2012), Auerbach and Gorodnichenko (2013), Candelon and Lieb (2013), Owyang, Ramey and Zubairy (2013), and Riera-Crichton, Vegh and Vuletin (2015).

Based on the conjecture that the effect of government spending varies according to the financial environment, state-dependent impulse responses are calculated for a panel of OECD countries using the local projection method advocated by Jordà (2005), where the size of the multiplier depends on the credit regime, being expansionary or contractionary. Specifically, fiscal multipliers are evaluated under the most extreme financial conditions, that is, during episodes of rapid credit booms and severe credit crunches. Unanticipated innovations in public expenditure are identified using forecast errors of the OECD government spending projections. In addition, by distinguishing between positive and negative shocks – i.e., increases and decreases in government spending –, the non-linear approach enables to gauge the economies’ true response to procyclical and countercyclical fiscal behavior in different credit regimes.⁴ Finally, the exploration of the response of the key components of private demand and unemployment sheds further light on the strength of fiscal policies in curbing the adverse effects of the credit cycle, and the channels through which they propagate to the real economy. Insights into the underlying transmission mechanisms should help frame fiscal policy decisions in order to tame the overheating in the economy during excessive credit booms, and reverse the downward

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³Existing studies provide a range of estimates of the government spending multiplier from less than 0 to well over 3, depending on the identifying assumptions and the state of the economy, among other factors. For critical surveys of the literature on fiscal multipliers, see Hall (2009) and Ramey (2011).

⁴Throughout the analysis, procyclical (countercyclical) fiscal policy refers to changes in government spending that are positively (negatively) correlated with the state of the credit cycle.
spiral of aggregate demand when the bust comes.

The findings of the empirical analysis establish the importance of the state of credit markets in predicting the extent to which fiscal intervention can be effective in industrialized economies. Three main results emerge. First, regime-specific impulse responses display a strong and statistically significant reaction of real GDP to fiscal policy shocks during episodes of severe credit contractions. On the contrary, when credit growth is excessive, the average response of output to a change in government spending is close to zero, and not significant in statistical terms. Second, distinguishing between increases and decreases in public expenditure reveals that countercyclical fiscal stance is desirable both when credit markets are dysfunctional, and when credit is abundant. In fact, fiscal austerity measures have essentially no impact on real GDP across the credit cycle. However, even though positive government spending shocks could stimulate the economy in periods of large credit expansions, consolidation during the boom years can help create fiscal space to stabilize the financial sector and boost economic recovery when credit markets collapse. Therefore, commitment to fiscal discipline in the expansionary regime can facilitate macroeconomic stability in the long run at a relatively low cost. Third, multipliers of private consumption, unemployment, and the weak response of private investment during credit crunches in particular suggest that fiscal policies could be more efficient if government spending would be targeted directly to repair and strengthen the private balance sheets. Fixing the financial system by reestablishing the flow of credit to the economy would in turn revive market confidence, crowd in private investment, and restore economic growth.

The remainder of the chapter proceeds as follows. Section 2.2 offers a brief description of the data and describes the methodology. Section 2.3 presents the empirical results. Section 2.4 considers the broader implications of the main findings, and finally concludes.

### 2.2 Data and methodology

#### 2.2.1 Data

The study makes use of a comprehensive dataset including 24 OECD economies over the period 1985-2012. Data for real GDP, real government spending, real private consumption, real private investment, consumer price index, and unemployment rate come from the OECD’s Statistics and Projections database. In line with the related literature, government spending refers to the sum of real fiscal expenditure and the social insurance contributions of central government.

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5 The countries are Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, Norway, Poland, Portugal, Spain, Sweden, the United Kingdom, and the United States.
public consumption expenditure and government gross capital formation. Fiscal policy shocks are identified using government spending forecast errors constructed by Auerbach and Gorodnichenko (2013). Specifically, unanticipated changes in public spending are computed as the difference between actual, first-release series of the government spending growth rate and the forecast series prepared by professional forecasters. Series of credit to the non-financial private sector by domestic banks is obtained from the Bank of International Settlements (BIS) database. Private credit is converted into real terms using consumer price indices, and all variables except for unemployment rate are in logs.

### 2.2.2 Methodological framework

Following Auerbach and Gorodnichenko (2013), regime-specific impulse response functions are estimated with the local projection method introduced by Jordà (2005). The main advantage of using direct projections is that it conveniently accommodates state dependence without imposing any dynamic restrictions implicitly embedded in VARs, for instance. Since it does not constrain the shape of the impulse responses, the estimation is more robust to misspecification errors. This single-equation approach only requires the estimation of a collection of regressions for each horizon and variable of interest. In particular, impulse response functions are obtained here by directly projecting output, private consumption, private investment, or unemployment rate on its lags and on the lags of government spending. Potential heteroskedasticity and error correlation problems across countries and time are addressed by using White-robust standard errors.

The baseline specification to calculate non-linear government spending multipliers for GDP ($Y_{i,t}$) – or any other macroeconomic variable – at the horizon $h$ is given by the following fixed effects panel data model:

$$Y_{i,t+h} = \alpha_{i,h} + I(\theta_{i,t-1})\beta_{C,h}FE_{i,t}^G + (1 - I(\theta_{i,t-1}))\beta_{E,h}FE_{i,t}^G$$

$$+ I(\theta_{i,t-1})\Psi_{C,h}(L)Y_{i,t-1} + (1 - I(\theta_{i,t-1}))\Psi_{E,h}(L)Y_{i,t-1}$$

$$+ I(\theta_{i,t-1})\Omega_{C,h}(L)G_{i,t-1} + (1 - I(\theta_{i,t-1}))\Omega_{E,h}(L)G_{i,t-1} + \epsilon_{i,t,h}, \quad (2.1)$$

with

$$I(\theta_{i,t}) = \frac{e^{-\gamma\theta_{i,t}}}{1 + e^{-\gamma\theta_{i,t}}}, \quad \gamma > 0.$$

---

6. Data for the OECD’s forecasts is available only in June and December of each year, therefore, all series have been converted to semiannual frequency. The sample for government spending forecast errors ends in 2008. For a thorough discussion on the conveniences of employing forecast errors based on OECD projections, see Auerbach and Gorodnichenko (2013).
where the subscripts $i$ and $t$ index countries and time, $\alpha_i$ captures country fixed effects, $G_{i,t}$ refers to government spending, and $FE^G_{i,t}$ is the government spending forecast error based on the projections prepared by professional forecasters at time $t-1$ for period $t$. The treatment $FE^G_{i,t}$ may be understood as a series of unanticipated innovations in public expenditure, and the essential coefficients $\{\beta_{C,h}\}_{h=0}^{H}$ and $\{\beta_{E,h}\}_{h=0}^{H}$ measure the average response of output to a government spending shock during credit contractions and expansions, respectively.\(^7\) Note that the dynamic impact of a shock is obtained from separate regressions for each horizon $h = 1, 2, ..., H$. Unlike in standard VAR models, the lag polynomials only enter as controls in Equation 2.1, and they are not used to derive the impulse responses. $\Psi(L)$ and $\Omega(L)$ correspond to lag operator polynomials of order 4, to control for the history of government spending shocks. $I(\theta_{i,t})$ is a smooth transition function that varies between 0 and 1 depending on the credit regime of the economy, and can be interpreted as the probability of being in a credit contraction, where a contraction is defined as a period in which $I(\theta_{i,t})$ is greater than 0.8.\(^8\) The parameter $\theta_{i,t}$ measures the state of the credit cycle in country $i$, given by the deviation of the 7-quarter moving average of the growth rate of private credit from its trend, normalized to have zero mean and unit variance.\(^9\) The trend is extracted using the Hodrick and Prescott (1997) filter, with the smoothing parameter set to 10,000.\(^10\) In addition, according to the panel average, a typical OECD economy – as well as the United States – spends about 23% of the time in a contractionary credit regime, therefore the curvature in the transition function is calibrated to $\gamma = 1.7$.\(^11\) Throughout the analysis, government spending multipliers are estimated for the most severe credit crunches (i.e., $I(\cdot) \approx 1$) and largest credit booms (i.e., $1 - I(\cdot) \approx 1$).

The key contribution of the study to the emerging literature on non-linear government spending multipliers is to analyze how the macroeconomic effects of fiscal policies depend on the credit regime. As argued before, focusing solely on the state of the business cycle may be misleading under extreme financial conditions. In support of this claim, the most recent crisis made it abundantly clear that business fluctuations cannot be looked at in isolation from developments in financial markets. In particular, financial frictions give rise to credit cycles distinct from the business cycle, characterized

\(^7\)The corresponding linear multiplier can be easily obtained when the impulse responses in Equation 2.1 are restricted to be identical across the different states of the credit cycle, i.e., $\beta_{C,h} = \beta_{E,h}$ for all $h$.

\(^8\)This is consistent with Auerbach and Gorodnichenko (2012), where a country is defined to be in an economic recession if $I(\theta_{i,t}) > 0.8$.

\(^9\)One-period lag of $\theta_{i,t}$ is considered to minimize the contemporaneous correlation between government spending shocks and the variation in private credit.

\(^10\)The very high smoothing parameter ensures that the filter removes even the lowest frequency variations in the private credit series (see Auerbach and Gorodnichenko (2013) for details).

\(^11\)The fraction of contractions in the credit series is calculated by employing the Bry and Boschan (1971) dating algorithm, where the duration of a contractionary phase is the number of periods between a peak and the subsequent trough.
by lower frequency and larger amplitude (Aikman et al., 2014). Ignoring these differences can lead to
erroneous policy responses, especially because policymakers tend to overlook that a credit cycle has a
longer duration than a business cycle. In the context of financial downturns, Drehmann et al. (2012)
refer to this phenomenon as "unfinished recessions". Figure 2.1 shows for selected OECD countries
that the smooth transition function in Equation 2.1 performs well in capturing the disparities between
the cyclical dynamics of private credit and output. Note that the state of the business cycle is
determined in a similar manner as for the credit cycle, with the weight given by the growth rate of
real GDP.\(^{12}\) Some of the most striking examples of "unfinished recessions" include the financial crisis
in the Nordic countries (Finland and Sweden) in the early 1990s, the Savings and Loan crisis of the
1980s and 1990s in the U.S., the Mexican peso crisis that erupted in December 1994, and the most
recent financial recession in Spain.

While the baseline specification takes account of the differences across regimes, Riera-Crichton
et al. (2015) demonstrate that ignoring whether government spending is going up or down during
economic recessions and expansions yields biased estimates of the fiscal multiplier. They show that the
problem originates in the fact that output does not respond symmetrically to increases or decreases
in government spending, when distinguishing between procyclical and countercyclical fiscal behavior.
Regarding the sample considered, in as much as 50% of the cases government spending is procyclical,
i.e., government spending is going up in credit booms and going down in credit busts. Thus, in
order to avoid the introduction of potential bias, Equation 2.1 is modified to estimate the effects of
unanticipated increases \((FE_{it}^{G_{POS}} > 0)\) and decreases \((FE_{it}^{G_{NEG}} < 0)\) in government spending during
credit contractions and expansions, separately:

\[
Y_{it+h} = \alpha_{i,t} + I(\theta_{i,t-1})\beta_{C,h}^{POS} FE_{it}^{G_{POS}} + (1 - I(\theta_{i,t-1}))\beta_{E,h}^{POS} FE_{it}^{G_{POS}}
\]

\[
+ I(\theta_{i,t-1})\beta_{C,h}^{NEG} FE_{it}^{G_{NEG}} + (1 - I(\theta_{i,t-1}))\beta_{E,h}^{NEG} FE_{it}^{G_{NEG}}
\]

\[
+ I(\theta_{i,t-1})\Psi_{C,h}^{POS} (L)Y_{it-1}^{POS} + (1 - I(\theta_{i,t-1}))\Psi_{E,h}^{POS} (L)Y_{it-1}^{POS}
\]

\[
+ I(\theta_{i,t-1})\Psi_{C,h}^{NEG} (L)Y_{it-1}^{NEG} + (1 - I(\theta_{i,t-1}))\Psi_{E,h}^{NEG} (L)Y_{it-1}^{NEG}
\]

\[
+ I(\theta_{i,t-1})\Omega_{C,h}^{POS} (L)G_{it-1}^{POS} + (1 - I(\theta_{i,t-1}))\Omega_{E,h}^{POS} (L)G_{it-1}^{POS}
\]

\[
+ I(\theta_{i,t-1})\Omega_{C,h}^{NEG} (L)G_{it-1}^{NEG} + (1 - I(\theta_{i,t-1}))\Omega_{E,h}^{NEG} (L)G_{it-1}^{NEG} + \epsilon_{i,t,h},
\]

where \(Y_{it}^{POS} = Y_{it-1}^{POS} \) and \(G_{it-1}^{POS} = G_{it-1}^{POS} \) if \(FE_{it}^{G_{POS}} = FE_{it}^{G_{POS}} \), and zero otherwise, and similarly,
\(Y_{it}^{NEG} = Y_{it-1}^{NEG} \) and \(G_{it-1}^{NEG} = G_{it-1}^{NEG} \) if \(FE_{it}^{G_{NEG}} = FE_{it}^{G_{NEG}} \), and zero otherwise.\(^{12}\) As in Auerbach and Gorodnichenko (2013), \(\gamma = 1.5\) is fixed so that a typical economy spends about 20% of the
time in a recessionary regime, which is consistent with the duration of recessions in the U.S. identified by the NBER.
Figure 2.1: Transition dynamics across regimes of GDP growth and private credit growth

Note: The figures show the dynamics of smooth transition functions $I(\cdot)$ for selected OECD countries between 1985-2012. The weights on recession regimes and contraction regimes are given by the growth rates of real GDP (black lines) and real private credit (gray lines), respectively.
2.3 Estimation results

This section first presents impulse responses of real GDP to a 1 percent change in government spending for each of the above model specifications. In what follows, responses are estimated for the major components of private demand as well as for unemployment, to get a grasp of the potential mechanisms in different credit regimes that could explain the results. Fiscal multipliers are scaled to ensure that a shock in $FE^G_{i,t}$ changes government spending by unity. In addition, 90 percent confidence bands associated with the impulse response functions are computed using the standard errors of the estimated coefficients of interest.

2.3.1 Fiscal multipliers in credit contractions and expansions

Based on Equation 2.1, the average cumulated response of real output is computed for 3 years following an unanticipated 1 percent government spending shock during credit crunches and credit booms (Figure 2.2). The first result that emerges is that the fiscal multiplier in severe credit contractions is positive on impact, and statistically significant for the next 3 periods, whereas the response of real GDP in strong credit expansions is not significantly different from zero at any horizon considered. Following Auerbach and Gorodnichenko (2013), spending multipliers are then constructed by multiplying the estimated impulse responses by the sample-period U.S. mean ratio of GDP to government purchases ($\approx 5.12$). The average multiplier in contractionary regimes is about 2.69, and reaches a maximum of 3.67 after 2 years. In sharp contrast, the mean response in credit expansions is only 0.03, and never statistically significant.

Both subfigures in Figure 2.2 additionally report the impulse responses obtained from the linear specification of the baseline model, i.e., by ignoring the distinction between credit contractions and expansions. The average linear multiplier over three years is slightly above one – when converting percent changes into dollar changes as before –, but responses are only marginally significant in the first two years. For the next two periods, responses remain positive, but not significant in statistical terms. Since OECD economies spend on average only about 23% of the time in a contractionary regime, the estimates of the linear model are likely to be driven by the muted effect of fiscal shocks in credit booms, substantially understating the impact in contractions, yet, overestimating it in expansions. Therefore, it is crucial to differentiate between the states of the credit cycle in order to identify the true size of the corresponding government spending multiplier instead of evaluating the

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13 Results are robust to the inclusion of year fixed effects, not reported here to save space.
14 This result is consistent with the previous literature on single government spending multipliers, exemplified by the work of Blanchard and Perotti (2002).
average effect across different regimes.

The findings of this subsection pose new challenges to policymakers. Clearly, the fiscal policies’ effectiveness depends largely on the state of credit markets. Moreover, while there exist considerable differences between business cycle fluctuations and the cyclical dynamics of private credit (see Figure 2.1), state-dependent fiscal multipliers in severe credit crunches and rapid credit booms are highly comparable to those obtained in periods of deep economic recessions and large expansions (see, for instance, Bachmann and Sims, 2012; Auerbach and Gorodnichenko, 2013; Riera-Crichton et al., 2015). This calls for significant adjustments to macroeconomic policies, by incorporating the empirical realities of the credit cycle.

2.3.2 State-dependent multipliers when government spending increases and decreases

There has been no distinction made between fiscal stimuli and fiscal adjustments up to this point, thus, asymmetric responses to increases and decreases in government spending are explored next. To this end, fiscal multipliers are estimated using Specification 2.2, where positive and negative values of the forecast error indicate whether government spending goes up \((FE_{G,i,t}^G > 0)\) or down \((FE_{G,i,t}^G < 0)\) during credit contractions and expansions. As forecast errors are positive about 49% of the time and negative 51% of the time in the sample, interacting this new dimension with the state of the credit cycle yields fairly robust and comparable estimates. In addition, distinguishing between the resulting scenarios enables to evaluate the size of procyclical (contraction and \(FE_{G,i,t}^G < 0\), or expansion and
Fiscal multipliers in credit contractions and expansions, associated with increases and decreases in government spending: real GDP

Cumulative spending multipliers for each of the four possible cases are illustrated in Figure 2.3. By comparing the estimates to the ones obtained in Section 2.3.1, several differences emerge. Most importantly, averaging across government spending in credit contractions produces a large downward bias in the estimated response to a countercyclical fiscal policy. The true size of the multiplier associated with contractions following an unanticipated 1 percent increase in government spending is about 5.07 over three years, and reaches a peak of 7.44 after three semesters (Figure 2.3/(a)).

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15Positive (negative) values of the point estimates of the impulse response functions following an unanticipated decrease in government spending ($FE_{i,t}^G < 0$) correspond to a decrease (increase) in the dependent variable.

16Note that this exceptionally large fiscal multiplier applies to very severe credit contractions, such as the ones experienced in many OECD countries during the recent global financial crisis. Consistent with related articles, the focus of this study is to evaluate the size of government spending multipliers under the most extreme conditions, that is, under deep credit crunches and very large credit expansions.
2.3. Estimation results is about two times the magnitude of the response, when ignoring whether government spending increases or decreases during a contractionary episode (see Figure 2.2/(a)). In contrast, Figure 2.3/(b) shows that the procyclical spending multiplier associated with credit crunches is remarkably different. The contemporaneous response of output to a decrease in government spending is about 1.45 and marginally significant, but the responses turn negative, although not statistically different from zero in all subsequent periods. In sum, these estimates imply that by distinguishing between increases and reductions in government spending in times when credit markets are exceedingly tight, a counter cyclical fiscal policy would substantially boost economic performance, whereas austerity packages would have virtually no impact on real GDP.

The output effects of government spending shocks in credit booms are not as unambiguous. Recall that the size of the multiplier in expansions following an unanticipated change in government spending is close to zero – and even negative at some horizons –, and not statistically significant (see Figure 2.2/(b)). It appears that this is not necessarily the case, when taking account of the differential impact of fiscal stimuli and fiscal adjustments. In fact, the response to a procyclical fiscal stance is positive, and borderline significant on impact, and it does breach statistical significance after 2.5 years (Figure 2.3/(c)). The three-year average multiplier is about 2.35. The response of output in the expansionary regime to a countercyclical fiscal policy is somewhat weaker (see Figure 2.3/(d)). The impact multiplier is -0.62, and the response is nearly -1 on average over three years, but generally one cannot reject the null that the response is zero for any horizon. Hence, when not considering the statistically non-significance observed for most of the estimates associated with credit expansions, it seems that irrespective of the fiscal stance, a change in government spending could potentially stimulate output. In other words, during large run-ups in private credit markets, a one-dollar spending cut as well as a dollar increase would raise output in the next three years, by about 1 dollar and 2.35 dollars on average, respectively. Given that excessive private borrowing often leads to financial and economic dislocations, however, a countercyclical fiscal behavior may be more rewarding in the long run, as it would both help constrain the boom and improve the fiscal space by reducing the debt-to-GDP ratio.

The empirical findings presented so far suggest that policymakers should focus on building up buffers during large credit expansions and make use of them in times of severe credit crunches to stabilize the economy. Nevertheless, the main results raise important questions about the underlying propagation mechanisms. Although a formal investigation of the potential transmission channels is beyond the scope of this article, the following subsection aims to provide a better understanding of
how fiscal shocks affect economic activity across the credit cycle.

2.3.3 Disentangling the fiscal policy effects in credit contractions and expansions

It is now clear that the size of the fiscal multiplier differs according to the state of credit markets. In what follows, analyzing the behavior of the key components of private demand and unemployment helps to uncover some further insights on the empirical relationship between government spending shocks and the real economy. To this effect, Equation 2.2 is re-estimated using private consumption, private investment, and unemployment rate as the dependent variable \( Y_{i,t} \). Figures 2.4 to 2.6 present the respective impulse responses to increases and decreases in government spending during severe credit contractions and large credit expansions.

The first thing to notice is that private consumption is the main channel through which an expansionary fiscal policy affects economic growth in times of financial distress (see Figure 2.3/(a) and Figure 2.4/(a)). When taking the ratio of private consumption to government purchases for the United States \((\approx 3.5)\), the average size of the multiplier is about 4.52. Figure 2.5/(a) reveals that the impact on private investment is much weaker. The contemporaneous response is close to zero, but it becomes positive and statistically significant at some horizons. The average multiplier over three years is about 1.1, and peaks at a maximum of 1.97 after 4 semesters when using the ratio of private investment to government spending in the United States \((\approx 0.8)\). In addition, Figure 2.6/(a) shows that when credit dries up, a debt-financed expansionary fiscal policy proves to be successful in reducing unemployment, shrinking it by as much as 0.5 percentage point.

Recall that the spending multipliers are evaluated here under very tight financial conditions, typically accompanied by deep economic recessions. The estimated responses corresponding to such extreme events thereby indicate that fiscal expansion can be a powerful tool to stimulate output, as an increase in government expenditure crowds in private demand (private consumption in particular), moreover, it also contributes to job creation. The relatively small and borderline significant effect observed for private investment can be explained by the binding liquidity constraints during severe credit downturns. When credit markets are extremely tight, given the shortfall of available financial resources, investor confidence and activity cannot be completely restored. It appears that debtors can simply not spend more if their creditors insist they cut back. In this regard, fiscal policy is less effective in balance sheet recessions than in normal recessions, since heavily indebted agents are likely to prioritize the repayment of their debt over additional spending on investment. This result
2.3. Estimation results

Figure 2.4: Fiscal multipliers in credit contractions and expansions, associated with increases and decreases in government spending: private consumption

Note: Solid black lines represent the average cumulated response of real private consumption to a government spending shock \( FE_{Gi,t} \) in the following cases: (a) credit contraction and increase in government spending, (b) credit contraction and decrease in government spending, (c) credit expansion and increase in government spending, (d) credit expansion and decrease in government spending. Dashed lines correspond to 90% confidence bands. Horizons are considered at the semiannual frequency.

underlines the importance of the composition of fiscal policy for economic recovery in the aftermath of a financial meltdown. Similarly, Eggertsson and Krugman (2012) and Borio (2014) argue that offsetting an economic downturn from private debt overhang can only be successful if fiscal stimulus addresses financial imbalances via debt relief first.

The multiplier of private consumption associated with spending decreases in credit crunches (Figure 2.4/(b)) likewise closely resembles the response of output to a procyclical fiscal policy in a contractionary regime (Figure 2.3/(b)). While consumption initially suffers, with an impact multiplier nearly one and marginally significant, it gradually decreases and becomes insignificant. By the third year, impulse responses turn negative (i.e., private consumption starts to increase) and borderline significant. A possible explanation for such patterns is that fiscal adjustments during credit contractions trigger an immediate increase in the rate of unemployment (Figure 2.6/(b)), coupled
Figure 2.5: Fiscal multipliers in credit contractions and expansions, associated with increases and decreases in government spending: private investment

Note: Solid black lines represent the average cumulated response of real private investment to a government spending shock ($FE_{G_{i,t}}$) in the following cases: (a) credit contraction and increase in government spending, (b) credit contraction and decrease in government spending, (c) credit expansion and increase in government spending, (d) credit expansion and decrease in government spending. Dashed lines correspond to 90% confidence bands. Horizons are considered at the semiannual frequency.

with a fall in private consumption. Simultaneously, a decline in public spending may also cause price levels to go down, having a positive effect on aggregate demand in the medium run. Meanwhile, the average multiplier of private investment following a spending decrease in credit contractions is only about -1 over three years, but one cannot reject the null that responses are zero for most horizons (Figure 2.5/(b)). Hence, if a procyclical fiscal policy has any effect on economic growth in periods when credit markets are dysfunctional, it propagates by and large through private consumption.

In contrast, the response of output to a positive fiscal shock in an expansionary credit regime is more correlated with private investment. Significant increases in real GDP about 2.5 years after a rise in government expenditure reflect the run-up in private investment (Figure 2.5/(c)), accompanied by an approximately 0.5 percentage point fall in unemployment (Figure 2.6/(c)). The responses are statistically significant at the longer horizon, and an additional dollar of government spending
2.3. Estimation results

Figure 2.6: Fiscal multipliers in credit contractions and expansions, associated with increases and decreases in government spending: unemployment rate

Note: Solid black lines represent the average cumulated response of unemployment rate to a government spending shock \( FE_{i,t}^G \) in the following cases: (a) credit contraction and increase in government spending, (b) credit contraction and decrease in government spending, (c) credit expansion and increase in government spending, (d) credit expansion and decrease in government spending. Dashed lines correspond to 90% confidence bands. Horizons are considered at the semiannual frequency.

Crowds in up to 3.75 dollars of private investment by the third year. Notwithstanding, private consumption remains largely unchanged in response to spending increases during credit expansions (see Figure 2.4/(c)). These findings raise important concerns about procyclical fiscal policies in times of rapid credit growth, as an increase in government spending may contribute to greater financial deepening, excessive borrowing, and speculative investment activities, which often end in devastating financial crises.

Finally, the effects of a countercyclical fiscal policy in credit booms are somewhat puzzling. Even though not significant in the statistical sense, a reduction in government spending in an expansionary regime increases output to some extent (Figure 2.3/(d)). Surprisingly, however, such stimulatory effects are not apparent in the response of private demand. On the contrary, Figure 2.5/(d) shows that a one-dollar spending cut decreases private investment by about 1.75 dollars on impact, and the
responses are significantly different from zero in the first two semesters. The decline in investment is followed by a fall in private consumption (Figure 2.4/(d)) and an increase in unemployment (Figure 2.6/(d)), with variations breaching statistical significance by the last semester. Thus, in times of large credit expansions, the transmission channels of fiscal adjustments remain an open question to be investigated. Nevertheless, engaging in fiscal consolidation and conducting countercyclical fiscal policy in a low interest rate environment may help reduce the potential vulnerabilities associated with excessive debt accumulation at a relatively low cost.

2.4 Discussion and concluding remarks

The results presented in this chapter do not always fall in line with the findings of the literature on fiscal multipliers. Yet, this empirical fact emerges only when distinguishing between government spending increases and decreases along the credit cycle. The traditional Keynesian thinking as well as a number of more recent works (e.g., Bachmann and Sims, 2012; Auerbach and Gorodnichenko, 2012, 2013) argue that fiscal policy is more effective in times of economic recessions, with increases in government expenditure crowding in private demand. In addition, Bachmann and Sims (2012) emphasize the role of confidence in the propagation mechanism, according to which government spending shocks during recessions are particularly geared toward investment, which in turn stimulates productivity in the private sector and output.\(^\text{(17)}\) While the neoclassical and standard New Keynesian models imply that government purchases tend to crowd out private expenditure, more recent variants of dynamic general equilibrium models extended with rule-of-thumb consumers (Galí, López-Salido and Vallés, 2007), binding zero lower bound episodes (e.g., Christiano et al., 2011; Woodford, 2011), and costly financial intermediation (Canzoneri, Collard, Dellas and Diba, 2015) are consistent with existing evidence on the expansionary effects of government spending.\(^\text{(18)}\)

In some respects, the patterns of the non-linear effects of fiscal shocks across the credit cycle diverge from the conventional wisdoms. The two most notable differences are i) the feeble response of private investment, as opposed to the unusually strong positive reaction of private consumption, to a countercyclical fiscal policy during severe credit contractions, and ii) the crowding-in effect of a procyclical fiscal policy on private investment in times of excessive credit booms. The first result suggests that whenever credit frictions are pervasive, an expansionary fiscal policy can be

\(^{17}\) For an early contribution on the complementary effect between public investment and private sector productivity, see Aschauer (1989).

\(^{18}\) The underlying crowding-out mechanisms are described in detail in Christiano and Eichenbaum (1992), Baxter and King (1993), Pattás and Mihov (2001), and Linnemann and Schabert (2003), among others.
very successful in offsetting the collapse in private consumption. However, unlike the predictions of Keynesian theory for economic recessions, traditional fiscal stimulus itself is not powerful enough to stabilize credit markets and revive investor confidence and activity in periods of financial turmoil, when liquidity constraints are binding. Corsetti et al. (2012) derive a similar prediction by estimating the effects of government spending shocks during financial crises, i.e., in economic recessions when access to credit is severely restricted. Regarding the second discrepancy, it seems that a positive innovation in public spending is compatible with an increase in private investment and growth, even during large expansions.\textsuperscript{19} Intuitively, a reason for such crowding-in effect is that during a credit frenzy bank lending standards are extremely loose, thereby investment in the private sector is less affected by an increase in interest rates caused by a surge in government spending. Hence, when financial markets become overly turbulent, the complementary effect supported by the Keynesian view is likely to prevail over the crowding-out effect advocated by the neoclassical theory, and a rise in public expenditure can lead to further increases in private investment. Interestingly, private consumption remains largely unchanged in response to a procyclical fiscal policy during rapid credit expansions, which points to the rather speculative nature of private investment in such episodes.

The findings of the chapter suggest that the financial environment at the time the government expenditure becomes effective matters. Successful policy packages should therefore take account of credit market dynamics besides the phases of a typical business cycle to achieve the desired effect. Above all, since deficit-financed government spending may reduce the ability to cope with deep and long-lasting financial recessions, fiscal consolidation should take place during economic expansions associated with credit booms, and public reserves should be used to relieve private debt burdens and restore aggregate demand in times of severe credit crunches. In this way, anchors in the fiscal regime can also help restrain the build-up of unsustainable booms and prevent excessive private investment. In terms of future research, analyzing the composition of government spending would be vital for a better understanding of the effectiveness of fiscal interventions during financial crises, especially in situations where monetary policy is constrained by the zero lower bound on interest rates.

\textsuperscript{19}Empirical evidence suggests that rapid credit booms are typically associated with periods of strong economic expansion (see, e.g., Mendoza and Terrones, 2012).
The evolution of economic convergence in the European Union

3.1 Introduction

The accession of eight Central and Eastern European countries (CEEC), Cyprus, and Malta on 1 May 2004 marks a significant event in the enlargement process of the European Union (EU). Soon thereafter Bulgaria and Romania joined the EU on 1 January 2007, raising the number of former Communist Bloc countries among EU members to ten. Following successful transformation of their political and legal system and the transition from planned to market economy during the early 1990s, these countries were faced with the task of catching up with the economies of Western Europe (see, e.g., Sachs, 1996). Economic convergence constitutes an essential ingredient for common structural and monetary policies, and there are good reasons to expect increased per capita real income convergence along the road to EU accession. European countries took major steps toward economic integration in recent decades, including the liberalization of capital and labor markets, harmonization of tax policy, and the foundation of the European Economic and Monetary Union (EMU). Moreover, the 1992 Maastricht Treaty set an agenda for nominal and real convergence prior to entering the EMU, and the European Commission has put forward numerous policy initiatives aimed at the reduction of regional economic disparities and improving competitiveness among EU members (see, e.g., European Commission, 2007).

The neoclassical growth model introduced by Solow (1956) predicts that, with technological homogeneity and identical preferences, cross-country differences in per capita real income shrink as each economy approaches its balanced growth path in the long run, and ‘overall convergence’ holds between different countries. In contrast, New Growth Theories, starting with Romer (1986) and Lucas (1988), point out the absence of convergence between poor and rich countries in practice. This

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1This chapter is based on Borsi and Metiu (2015).
2The Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, and Slovenia.
controversy has spurred a wide range of convergence definitions and empirical testing methodologies.\(^3\) From a theoretical perspective, several modifications to the original neoclassical model have been proposed. Notably, Parente and Prescott (1994), Barro and Sala-i-Martin (1997), Basu and Weil (1998), Perez-Sebastian (2000), and Howitt and Mayer-Foulkes (2005) replace homogeneous technological progress across countries in the neoclassical production function with the assumption of country-specific technological growth rates. Moreover, Azariadis (1996) and Galor (1996) show that the neoclassical growth model can actually generate multiple equilibria; countries with identical economic structures need not converge to the same equilibrium growth path, instead some countries may converge to a high steady-state income level while others may face a poverty trap, giving rise to the ‘club convergence’ hypothesis.

Starting from the premise that closer economic integration may lead to increased convergence of per capita real income between different countries, this chapter investigates the evolution of convergence in a comprehensive sample including all 27 members of the enlarged EU. We employ a convergence test derived from a neoclassical growth model augmented with endogenous technological progress which differs across countries and over time. Following this econometric approach, we study economic transition and convergence from 1995 to 2010 between all 27 EU members. Furthermore, the exercise is repeated considering a longer period spanning from 1970 till 2010 for 21 EU countries. Our main contribution to the literature on European economic integration consists in establishing a set of novel stylized facts regarding real income convergence among European economies.

Phillips and Sul (2007a,b, 2009) show that the neoclassical growth model augmented with cross-country technological heterogeneity admits a non-linear factor representation. The resulting factor model captures a form of panel convergence comparable to the concept of conditional \(\sigma\)-convergence.\(^4\) We adopt this approach as it has several appealing features. From a theoretical point of view, it does not rely on homogeneous technological progress across countries and over time, a limiting assumption widely used in the existing literature. Another considerable advantage of the technique is that, unlike other time series methodologies, it does not require the existence of common stochastic trends, and

\(^3\) Most empirical convergence testing methods fall under two categories: cross-section augmented Solow regressions (Barro and Sala-i-Martin, 1992; Mankiw, Romer and Weil, 1992) and time series tests of unit root and cointegration (e.g., Evans and Karras, 1996; Evans, 1998; Siklos, 2010; Kutan and Yigit, 2005; Guetat and Serranito, 2007; Lopez and Papell, 2012). For an overview of the empirical techniques and their potential drawbacks, see Bernard and Durlauf (1996), Binder and Pesaran (1999), and Islam (2003).

\(^4\) The most widely applied empirical convergence concepts, originating with Baumol (1986), Barro and Sala-i-Martin (1992), and Mankiw et al. (1992), are those of \(\beta\)-convergence, understood as a tendency of poorer economies to grow faster than rich ones, and \(\sigma\)-convergence, which refers to a reduction of income dispersion between rich and poor countries; typically after controlling for country-specific characteristics, in which case we are talking about conditional convergence as opposed to unconditional convergence. The existing approaches also differ in their focus on whether economies grow at the same rate in the steady state vs. whether they converge to the same steady-state income level.
therefore allows individual transition paths to be transcriptionally divergent. Hence, we can trace the transition path of an economy toward the steady-state income level, which enables us to uncover different types of economic transition behavior, e.g., transitional divergence followed by catching-up and convergence. In addition, the non-linear factor model can distinguish between (i) convergence to a single steady state shared by all economies as predicted by the neoclassical growth model, (ii) overall divergence, and (iii) club convergence, which may be interpreted as convergence to multiple steady-state equilibria (see Azariadis, 1996; Galor, 1996). Convergence clubs can be identified within the panels under study based on a clustering algorithm developed by Phillips and Sul (2007b). Finally, the factor model measures both the speed and degree of convergence.

Our findings offer important insights on the economic convergence exhibited by the new EU members in light of the institutional reforms and macroeconomic adjustment processes that took place during the last few decades. To preview the results, we do not find overall real income per capita convergence in the EU-27, and we identify subgroups that converge to different steady-state equilibria. The failure of convergence within the EU conveys the key message that the hypothesis of a ‘multi-speed’ Europe prevails nearly thirty years after the Mediterranean enlargement and a decade after the Eastern enlargement. Remarkably, we do not find a clear relation between clustering and EMU membership, as euro area countries do not form a single convergence club. Instead, convergence clubs are formed mainly on the basis of geographic region, and a separation is found between post-communist economies and the old EU members in the long run. The CEEC showed substantial developments through the implementation of policies facilitating European cohesion. However, our results reveal that the pace of economic growth was insufficient to narrow the GDP per capita differences compared to Western economies. Moreover, we observe a gradual setback of Mediterranean countries, resulting in a South-East vs. North-West division of European economies by the mid-nineties.

The European sovereign debt crisis has brought to surface some of the underlying tensions within the EU along the division lines identified in this article. The existing literature suggests that differences in structural characteristics (e.g., production technology, preferences, and government policies) as well as initial conditions (e.g., the initial stock of labor and – physical and human – capital) play a role in the formation of convergence clubs (see, e.g., Durlauf and Johnson, 1995; Galor, 1996;

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5Greece entered the EU in 1981, while Portugal and Spain joined in 1986.
6The concept of a ‘multi-speed’ Europe refers to differentiated integration between countries. Proponents of this idea argue that different members of the European Union should integrate at different levels and pace, depending on the economic and structural characteristics of each country (see, e.g., Alesina and Grilli, 1993; von Hagen and Neumann, 1994; Stubb, 1996).
Thus, we conjecture that structural disparities within the EU may continue to pose further challenges in achieving economic convergence, unless policymakers consider reducing these differences by means of growth-enhancing structural reforms. Moreover, in the light of future EU enlargement, the timing and pace of economic integration is crucial, as premature integration may limit the growth path of an economy due to its potentially inferior starting conditions.

The remainder of the chapter is organized as follows. Section 3.2 summarizes the related literature on economic convergence in the EU. Section 3.3 offers a brief description of the methodological framework, while the data used in the analysis is presented in Section 3.4. The main empirical results are contained in Section 3.5, and finally, Section 3.6 summarizes our conclusions.

### 3.2 Related literature

There is a large body of empirical studies on macroeconomic convergence in Europe. A variety of different methods as well as sample periods have been previously considered, and the literature has so far led to mixed conclusions. The issue of real income convergence among European countries remains thus highly controversial.\(^7\)

One strand of the literature analyzes convergence at the regional level. For example, Quah (1996) argues that European regions cannot be viewed in isolation, instead physical location and geographical spillovers account for a considerable amount of regional income distribution dynamics. In a related paper, Sala-i-Martin (1996) analyzes $\beta$- and $\sigma$-convergence in real income per capita for 90 regions spanning eight European countries (Belgium, Denmark, France, Germany, Italy, the Netherlands, Spain, and the United Kingdom) between 1950-1990, and he finds that regional incomes converge at a moderate speed. In contrast, using a predictive density approach, Canova (2004) finds separation into convergence clubs along the North-South, rich-poor dimension among NUTS2 Western European regions. Similarly, Corrado, Martin and Weeks (2005) find no overall convergence in per capita real income at the NUTS1 regional level covering the EU-15 plus Norway. They show that geographical location as well as socio-demographic characteristics are highly correlated with the formation of convergence clubs. Ramajo, Marquez, Hewings and Salinas (2008) estimate the speed of convergence for a sample of 163 EU regions over the period 1981-1996. Their results provide further evidence in support of separate spatial convergence clubs, where the regions in the EU cohesion-fund countries

---

\(^7\)In our literature review we focus on papers that analyze real income per capita convergence in Europe. However, there is also a burgeoning literature that we do not survey here, which investigates the monetary effects of the common currency area (see, e.g., Goldberg and Verboven, 2005; Candelon, Kool, Raabe and Van Veen, 2007; Rogers, 2007; Siklos, 2010; Ehrmann, Fratzscher, Gürkaynak and Swanson, 2011; Lopez and Papell, 2012; Fischer, 2012).
(Ireland, Greece, Portugal and Spain) are found to converge faster than the rest of the regions.

The aggregate macroeconomic evidence has likewise led to mixed results. Carvalho and Harvey (2005) fit a multivariate structural time series model on real income per capita of 11 euro area countries from 1950 to 1997. They identify two groups – a high-income group (five core economies, Austria, and Finland) and a low-income group (Spain, Greece, and Portugal) – that exhibit growth convergence. In addition, they find that Ireland diverges from the rest of the countries, following its own growth path. Cunado and Perez de Gracia (2006) analyze real convergence in five Central and East European countries (both towards the German and the US economies) in a time series testing framework between 1950-2003. They reject the hypothesis of real convergence for the whole period considered. However, when allowing for structural breaks, they provide evidence in favor of a catch-up process during the 1990s-2003 period for three of the CEEC (Poland, the Czech Republic, and Hungary) towards Germany and only for Poland towards the US economy. Crespo Cuaresma, Ritzberger-Grünwald and Silgoner (2008) assess $\beta$-convergence in per capita real GDP between 1960-1998 for the EU-15 and show that EU membership significantly improves the degree of economic integration and long-term growth. They further argue that the positive effect of EU membership on growth is relatively higher for poorer countries. Finally, Cavenaile and Dubois (2011) find conditional $\beta$-convergence of real income per capita for the EU-27 between 1990-2007. Nevertheless, they show that the rates of convergence of the new entrants from Central and Eastern Europe and of the 15 Western countries significantly differ, pointing to the existence of different groups of convergence in the European Union.

Our analysis is most closely related to a handful of recent works that study economic convergence in Western Europe using the factor model proposed by Phillips and Sul (2007b). The model has been applied by Bartkowska and Riedl (2012) to test for convergence in per capita income for 206 regions in 17 Western European countries from 1990 to 2002. They detect six separate clubs on the regional level and show that starting conditions, such as the initial level of human capital and per capita income, are significant determinants of a region’s club membership, while structural characteristics play a relatively minor role. Further, Fritzsche and Kuzin (2011) use the same procedure to assess price level, unit labor cost, real per capita income, and productivity convergence for 12 members of the euro area, Denmark, Sweden, and the UK between 1960-2006. Their per capita income results point to the existence of three distinctive convergence clubs, albeit without clear regional linkages. Our work complements these related studies by including Central and Eastern European countries in addition to Western European ones. Moreover, while existing studies typically focus solely on
identifying the convergence clubs, we add to this literature by also analyzing the different types of economic transition dynamics along the path to convergence. This broader approach enables us to provide a comprehensive set of stylized facts on economic convergence in the EU.

3.3 Methodology

3.3.1 Theoretical framework

In the neoclassical growth model homogeneous technology is assumed, so that regardless of their initial conditions, all countries undergo technological progress at the same rate over time. This condition is overly restrictive, and it usually fails to account for the cross-country income heterogeneity observed in the data. The model can be augmented with endogenous technological progress which differs across countries and over time, such that the transition path of each economy toward the steady state level of per capita real income depends on country-specific technological growth rates (see, e.g., Parente and Prescott, 1994; Barro and Sala-i-Martin, 1997; Basu and Weil, 1998; Perez-Sebastian, 2000; Howitt and Mayer-Foulkes, 2005; Phillips and Sul, 2007b). The neoclassical growth model augmented with technological heterogeneity yields the following expression for period $t = 1, \ldots, T$ log per capita real income $y_{it}$ of country $i = 1, 2, \ldots, N$:

$$y_{it} = y_i^* + (y_{i0} - y_i^*)e^{-\beta_{it}} + a_{it}, \quad (3.1)$$

where $y_{i0}$ and $y_i^*$ are the initial and steady-state levels of log per capita income, respectively, $\beta_{it}$ is the time-varying speed of convergence rate, and $a_{it}$ is the log of technology accumulation for economy $i$ at time $t$. Following Parente and Prescott (1994), technology can be decomposed as $a_{it} = a_{i0} + \gamma_{it}a_t$, into initial technology accumulation $a_{i0}$ and the distance of country $i$ from publicly available advanced technology at time $t$, $\gamma_{it}a_t$. The parameter that measures this distance, $\gamma_{it}$, varies over time and across countries.

Under the assumption that advanced technology $a_t$ evolves according to a common trend $\mu_t$, the growth model admits a time-varying latent factor representation which can be expressed as:

$$y_{it} = \left( \frac{y_i^* + (y_{i0} - y_i^*)e^{-\beta_{it}} + a_{i0} + \gamma_{it}a_t}{\mu_t} \right) \mu_t = \delta_{it}\mu_t, \quad (3.2)$$

as shown by Phillips and Sul (2007b). The factor $\mu_t$ is a common steady-state trend function which may follow either a non-stationary stochastic trend with drift or a trend-stationary process. The
country-specific transition path of country $i$ to the common trend $\mu_t$ is captured by the time-varying loadings $\delta_{it}$ which absorb any idiosyncratic movements in $y_{it}$. The loadings represent a form of economic distance of each economy from the common trend, which may arise from differences in technological progress. The extent to which individual country characteristics differ across economies will be reflected in the diverse shapes of economic transition encompassed in $\delta_{it}$.

Relative income differentials between economies $i$ and $j$ can be written as:

$$y_{it} - y_{jt} = (\delta_{it} - \delta_{jt})\mu_t.$$  \hspace{1cm} (3.3)

Thus, the convergence of all $N$ economies to the common trend $\mu_t$ requires that $\delta_{it}$ and $\delta_{jt}$ converge to some common constant $\delta_i = \delta_j = \delta$ as $t \to \infty$ for $i,j = 1,2,\ldots,N$ and $i \neq j$, which implies that country-specific differences are eliminated over the long run. As proposed by Phillips and Sul (2007b), the loadings are assumed to follow a semiparametric process of the form:

$$\delta_{it} = \delta_i + \sigma_{it} \xi_{it}, \quad \sigma_{it} = \frac{\sigma_i}{\log(t)^{\alpha}}, \quad \sigma_i > 0,$$  \hspace{1cm} (3.4)

where the idiosyncratic terms $\xi_{it}$ are $i.i.d.(0,1)$ across $i$ but weakly dependent over $t$. The loadings $\delta_{it}$ converge slowly to the constant $\delta_i$ as $t \to \infty$ for $\alpha \geq 0$, and scaling by the slowly varying function $\log(t)^{\alpha}$ ensures a smooth transition path. The parameter $\alpha$ represents the rate at which cross-sectional heterogeneity decays to zero over time, that is, the speed of convergence.

We are interested in testing the hypothesis of convergence between all countries (overall convergence), against the alternative of no convergence for some country or countries. The alternative hypothesis includes divergence of all countries in the panel (overall divergence), or a situation in which sub-panels converge to different steady states with possibly some diverging units (club convergence).

The null hypothesis of overall convergence can be expressed as

$$H_0 : \lim_{t \to \infty} \delta_{it} = \delta,$$

or equivalently $\delta_i = \delta$ for all $i$ and $\alpha \geq 0$. The alternative hypothesis is given by

$$H_1 : \lim_{t \to \infty} \delta_{it} \neq \delta,$$

which corresponds to one of two cases, either overall divergence: $\delta_i = \delta$ for all $i$ with $\alpha < 0$; or club convergence: $\delta_i \neq \delta$ for some $i$ with $\alpha \geq 0$, or $\alpha < 0$. 
3.3.2 The log\((t)\) convergence test

The identification and estimation of the factor loadings \(\delta_{it}\) is not feasible without imposing additional structure and assumptions on the non-linear dynamic latent factor model. However, an equally suitable way to extract information about \(\delta_{it}\) required to test the hypotheses of interest is offered by constructing the following relative transition paths:

\[
h_{it} = \frac{y_{it}}{N^{-1} \sum_{i=1}^{N} y_{it}} = \frac{\delta_{it}}{N^{-1} \sum_{i=1}^{N} \delta_{it}}, \tag{3.5}
\]

which measure the loadings \(\delta_{it}\) in relation to the panel average at time \(t\), while removing the common steady-state trend \(\mu_t\). The variable \(h_{it}\) traces out an individual transition path over time for economy \(i\) in relation to the panel average. If the factor loadings \(\delta_{it}\) converge to \(\delta\), the relative transition paths given by \(h_{it}\) converge to unity. In that case, the cross-sectional variance of \(h_{it}\) converges to zero asymptotically:

\[
H_t = N^{-1} \sum_{i=1}^{N} (h_{it} - 1)^2 \to 0 \quad \text{as} \quad t \to \infty, \tag{3.6}
\]

where \(H_t\) measures the distance of economy \(i\) from the common limit. If convergence fails to hold, the distance remains positive as \(t\) goes to infinity. Thus, the statistical convergence property \(H_t \to 0\) translates into the null hypothesis of economic convergence between countries in the panel.

Phillips and Sul (2007b) propose a test for economic convergence based on the asymptotic convergence property given in Expression 3.6. This involves estimating the following regression by ordinary least squares:

\[
\log \left( \frac{H_1}{H_t} \right) - 2 \log (\log(t)) = a + b \log(t) + u_t, \tag{3.7}
\]

where \(t = \lfloor rT \rfloor, \lfloor rT \rfloor + 1, \ldots, T\), for some fraction \(r > 0\). The regression coefficient \(b\) provides a scaled estimator of the speed of convergence parameter \(\alpha\), specifically \(b = 2\alpha\). Thus, the null hypothesis of convergence can be tested by a one-sided \(t\)-test of the inequality \(\alpha \geq 0\) using the estimate \(\hat{b}\) and a heteroscedasticity and autocorrelation consistent (HAC) standard error. The null hypothesis is rejected at 95% significance level if \(t_{\hat{b}} < -1.65\). When the rejection of the null applies, a clustering procedure is performed, in which the \(\log(t)\) test is repeated in an iterative manner based on a set of criteria, in order to detect all possible subgroups that converge in the panel (see Appendix A for details). If no additional clubs are found, one may conclude that the remaining countries diverge.

8Note that \(\lfloor rT \rfloor\) denotes the integer part of \(rT\). As suggested by Phillips and Sul (2007b), in our empirical applications we set \(r = 0.3\) given that \(T \leq 50\).

Analyzing economic convergence within this framework has several appealing features. First, convergence is treated as an asymptotic property. Hence, the model is consistent with a wide range of transition dynamics toward the steady state. Different countries may follow substantially different relative transition paths outlined by $h_{it}$, including periods of transitional divergence and heterogeneity, yet convergence ultimately occurs when the property in Expression 3.6 holds in the long-run.

Second, we can distinguish empirically between different degrees of convergence. If the estimate $0 \leq \hat{b} < 2$ (and accordingly $0 \leq \hat{\alpha} < 1$), this implies convergence in a relative sense, while $\hat{b} \geq 2$ indicates absolute (level) convergence within the panel. Finally, we do not have to rely on any particular assumptions regarding the deterministic or stochastic trending behavior of $y_{it}$ and $\mu_t$.

### 3.4 Data

We investigate convergence between the 27 members of the European Union. Hence, the countries included are Austria (AUT), Belgium (BEL), Bulgaria (BUL), Cyprus (CYP), the Czech Republic (CZE), Denmark (DEN), Estonia (EST), Finland (FIN), France (FRA), Germany (GER), Greece (GRE), Hungary (HUN), Ireland (IRE), Italy (ITA), Latvia (LAT), Lithuania (LIT), Luxembourg (LUX), Malta (MAL), the Netherlands (NED), Poland (POL), Portugal (POR), Romania (ROM), Slovakia (SVK), Slovenia (SLO), Spain (ESP), Sweden (SWE), and the United Kingdom (UK). Per capita real income is measured by PPP converted annual real GDP per capita at 2005 constant prices from the Penn World Tables (Heston, Summers and Aten, 2012). We have two baseline samples. The first one spans from 1970 till 2010 and contains 21 countries (EU-21). Due to data limitations, time series for the Czech Republic, Estonia, Latvia, Lithuania, Slovakia, and Slovenia are absent from this panel. Therefore, we have chosen the longest time series available for all 27 EU members (EU-27), and the second baseline sample covers the period 1995-2010.

In what follows, we assess some elementary time series properties of the data, focusing our attention on characterizing the long-run behavior. First, we present a set of descriptive statistics in order to build some intuition on the economic performance of EU countries since the 1970s. In the sequel, we turn to a more formal econometric approach to shed further light on the nature of the data.

---

10 Notice that $\mu_t$ follows either a stochastic trend with drift or a trend-stationary process, both of which diverge at an $O_p(t)$ rate as $t$ goes to infinity. Hence, if $\delta_{it}$ converges at a faster rate than $O_p(t)$ to the constant $\delta$ (as measured by the convergence speed $\alpha$), then relative convergence implies absolute convergence. However, if $\delta_{it}$ converges at a slower rate than $O_p(t)$, then relative convergence holds while absolute convergence does not.
3.4.1 Descriptive statistics

Our empirical approach hinges upon the idea that European economies differ substantially in terms of the technology used in the production process. Recent studies of total factor productivity (TFP) for the EU-27 show that differences in per capita income between new and old EU members reflect to a large extent differences in aggregate TFP (see Burda and Severgnini, 2009; Marrocu, Paci and Usai, 2013). According to Marrocu et al. (2013), the technological heterogeneity observed in the EU stems from differences in the production structure and the level and scope of sectoral specialization between Western Europe and the CEEC. They show that over the last decade, the old EU members have specialized their production in knowledge-intensive services and gradually outsourced a large portion of their low-tech manufacturing to the new accession countries. This process is associated with significant differences in TFP levels and growth rates between European countries. Table 3.1 reports the TFP levels estimated by Marrocu et al. (2013) for 1999 and 2007 and the average TFP growth rates between 1999 and 2007, considering TFP as an index number with the European average set equal to 100. The table provides a good illustration of differences in productivity among European economies. In particular, while the new member states are still lagging behind the TFP levels of the old EU members, Marrocu et al. (2013) argue that a convergence process is at work and growth rates have been much higher in CEEC than in the West over the recent decade. This observation underlies our choice for an empirical methodology that accounts for technological heterogeneity in a convergence testing framework.

Figure 3.1 shows a scatter plot of log real GDP per capita in 1970 against log real GDP per capita in 2010 for the EU-21. The distance between the 45-degree line and each data point reflects the average growth rate over 40 years. As judged by the latter, European countries have been overall quite successful during the last four decades, as no country experienced a decline in real income per person on average.\footnote{For a detailed comparison, Table 3.6 in Appendix B shows real per capita income for the initial and last observations of the two samples considered.}

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>EU-15, Norway, Switzerland</td>
<td>115</td>
<td>113</td>
<td>0.48</td>
</tr>
<tr>
<td>12 new accession countries</td>
<td>41</td>
<td>50</td>
<td>2.80</td>
</tr>
<tr>
<td>Whole Europe</td>
<td>100</td>
<td>100</td>
<td>0.95</td>
</tr>
</tbody>
</table>

\textbf{Note:} Source: Marrocu et al. (2013), page 8.
3.4. Data

Figure 3.1: Per capita real income growth between 1970 and 2010 in the EU-21

There seems to be, however, substantial heterogeneity over the period considered. While some countries experienced relatively high mean rates of real per capita GDP growth, such as Malta, Bulgaria, Luxembourg, and Romania (4.3%, 3.3%, 2.9%, and 2.9%, respectively), most highly developed countries (e.g., Denmark, Netherlands, and Sweden) have been growing at a slower rate on average (around 1.5-1.6%). These figures suggest an economic catching-up of the relatively poorer countries, and it illustrates a somewhat idiosyncratic path in the case of Luxembourg. Disregarding the aforementioned high growth countries in the plot reveals another interesting pattern: while log real income per person varied between around 8.7 and 9.9 in 1970, it narrowed down to an interval between approximately 9.7-10.6 by 2010, which hints at a reduction in income dispersion from the initial period.

Figure 3.2 illustrates the evolution of cross-sectional real income dispersion over time, it thus reflects a notion of $\sigma$-convergence. For each year, we compute the sample standard deviation of log real GDP per capita across countries, and we take 5-year rolling averages to smooth out any short-run patterns. Figure 3.2/(a) plots cross-section dispersion across the EU-21, while Figure 3.2/(b) shows the same measure excluding the CEEC (Bulgaria, Hungary, Poland, and Romania). Real income dispersion decreased substantially for the EU-21 from 1970 until the mid-1980s. However, we can subsequently observe a transitional divergence period until the birth of the EMU in the late 1990s. As can be seen from a comparison of the two figures, this divergence was mainly due to the
CEEC, while dispersion seems unaffected by the foundation of the monetary union. Regarding the CEEC, the socialist economic system lost its impetus by the 1980s, and these countries were faced with rising debt and severe austerity measures. Hence, in the early 1990s, important political and institutional changes were undertaken, involving sizable macroeconomic adjustment processes, e.g., transition from planned to market economy, liberalization of prices, and privatization of state assets. These developments are in line with the dispersion dynamics observed.
3.4.2 Panel unit root tests

Next, we test for the presence of stochastic trends in real per capita income. From a statistical perspective, the presence of a – stochastic or deterministic – trend in the data is an important assumption underlying the non-linear factor model proposed by Phillips and Sul (2007b). Moreover, evidence for a unit root in the panel also has economic implications. Notably, in the standard Solow (1956) growth model, each economy converges to its unique balanced growth path and any country-specific deviation from the steady state is eventually eliminated. Consequently, deviations of each variable from the average across economies \((y_{it} - \bar{y}_t)\) should follow a stationary process (see Evans and Karras, 1996). Therefore, panel tests for a unit root in \(y_{it} - \bar{y}_t\) have been widely applied to assess economic convergence in the literature, see e.g. Evans and Karras (1996), Evans (1998), Kutan and Yigit (2005), Guetat and Serranito (2007), and Lopez and Papell (2012).

Given the differences in economic structure and development between our sample countries, we employ two panel unit root tests which are suitable for the analysis of dynamic heterogeneous panels. The first test, proposed by Im, Pesaran and Shin (2003), is based on pooled univariate augmented Dickey-Fuller (ADF) regressions, with the null hypothesis of a unit root in the panel (no overall economic convergence), against the alternative of stationarity of at least one series (at least one economy converges to the cross-sectional average \(\bar{y}_t\)). The Im-Pesaran-Shin test relies on independence between cross-sectional units. This assumption may be violated in practice, therefore, we also consider a block bootstrap version of the Im-Pesaran-Shin test proposed by Palm, Smeekes and Urbain (2011), that is robust to cross-sectional dependence stemming from a common factor structure in addition to a wide range of temporal dependencies (e.g., cross-unit cointegration).

Besides considering convergence with respect to the cross-sectional average, we follow Kutan and Yigit (2005) by testing for convergence to a benchmark country, and we opt for Germany as the economy that reflects core EU standards. The test regressions may generally contain an intercept and linear time trend. We include country-specific constants in order to allow for the possibility of growth convergence, consistent with Evans and Karras (1996). Besides, we consider a deterministic trend under the stationarity hypothesis in line with the non-linear factor model, such that the hypothesis of trend-stationarity is tested against stochastic non-stationarity. The lag length in the ADF regressions is chosen based on the Schwartz information criterion. Table 3.2 reports the test results.

In summary, the unit root tests lead to an unanimous rejection of overall economic convergence.

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12If this process is mean zero, there is level convergence between economies, otherwise each economy will converge to its own parallel growth path, i.e., convergence will occur between growth rates.
### Table 3.2: Panel unit root test results

<table>
<thead>
<tr>
<th>Test</th>
<th>Benchmark</th>
<th>Statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Im-Pesaran-Shin</td>
<td>$\bar{y}$</td>
<td>0.523</td>
<td>0.70</td>
</tr>
<tr>
<td>Im-Pesaran-Shin</td>
<td>$y_{\text{GER}}$</td>
<td>1.228</td>
<td>0.89</td>
</tr>
<tr>
<td>Palm-Smeekes-Urbain</td>
<td>$\bar{y}$</td>
<td>-4.370</td>
<td>0.76</td>
</tr>
<tr>
<td>Palm-Smeekes-Urbain</td>
<td>$y_{\text{GER}}$</td>
<td>-3.953</td>
<td>0.79</td>
</tr>
</tbody>
</table>

Sample: EU-27, 1995-2010

<table>
<thead>
<tr>
<th>Test</th>
<th>Benchmark</th>
<th>Statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Im-Pesaran-Shin</td>
<td>$\bar{y}$</td>
<td>-0.294</td>
<td>0.38</td>
</tr>
<tr>
<td>Im-Pesaran-Shin</td>
<td>$y_{\text{GER}}$</td>
<td>5.608</td>
<td>1.00</td>
</tr>
<tr>
<td>Palm-Smeekes-Urbain</td>
<td>$\bar{y}$</td>
<td>-4.690</td>
<td>0.77</td>
</tr>
<tr>
<td>Palm-Smeekes-Urbain</td>
<td>$y_{\text{GER}}$</td>
<td>-3.785</td>
<td>0.95</td>
</tr>
</tbody>
</table>

**Note:** Test statistics and p-values corresponding to the panel unit root test proposed by Im et al. (2003) and the block bootstrap panel unit root test proposed by Palm et al. (2011). The dependent variable is the time series of each economy relative to a benchmark that is either the panel average ($y_{it} - \bar{y}_t$), or Germany ($y_{it} - y_{\text{GER}t}$). Under the null hypothesis all series in the panel have a unit root, which is equivalent to no overall economic convergence between countries.

Within the EU. This result is robust to the choice of the benchmark as well as the employed test statistic. Nevertheless, the presence of stochastic trends in the panel does not necessarily imply that all economies are on diverging growth paths, since the tests do not rule out a situation in which one or more subgroups of countries converge to the respective subgroup-average, while others diverge. Moreover, when technological progress varies over time and in the cross-section, convergence may fail to hold even in the absence of stochastic trends in the data as shown by Phillips and Sul (2009). In the next section we present results from the log($t$) approach that tackles precisely these issues.

### 3.5 Empirical results

Applying the log($t$) convergence test and clustering algorithm to real per capita income, we uncover the following key facts:

**Fact 1.** There is no overall real income per capita convergence in the European Union: the null hypothesis of convergence is clearly rejected in all panels considered.

**Fact 2.** Subgroups converge to different steady-state equilibria, which highlights that a multi-speed Europe is currently an economic reality.
Fact 3. Convergence clubs are formed mainly on the basis of geographic region, and clustering is not necessarily related to EMU membership.

Fact 4. There is a clear separation between the CEEC and the old members within the EU in the long run, and the more recent period is characterized by a division along the South-East vs. North-West dimension.

3.5.1 Convergence and clustering

Looking at the empirical results in detail, we consider convergence in two baseline panels. These are real GDP per capita for the EU-21 sample for 1970-2010 ("long panel") and for the EU-27 sample for 1995-2010 ("short panel"). In addition, we investigate the EU-21 between 1995-2010 in order to confirm the robustness of our findings in the absence of the six countries that are missing from the EU-21 sample, namely, the Czech Republic, Estonia, Latvia, Lithuania, Slovakia, and Slovenia. The convergence club classification results are reported in Table 3.3. Moreover, Figure 3.3 depicts the corresponding relative transition curves of individual countries (\(\hat{h}_{it}\)) and the average transition curves for each club (\(\bar{h}_{clubt}\)). Recall that the relative transition path \(h_{it}\) measures the departure of each country \(i\) from the panel average. If the factor loadings \(\delta_{it}\) converge to a common constant \(\delta\), the transition paths \(h_{it}\) converge to unity. Other than that, the economic transition behavior can significantly differ across economies.

The null hypothesis of overall economic convergence is rejected at the 5% level in all three panels. Concerning the long panel, we identify four clubs and only one diverging country. Luxembourg shows distinct growth dynamics, being on a transition path permanently above all other countries during the period in question (see Figure 3.3/(a)), which confirms our earlier conjecture regarding its idiosyncratic growth path. Club 1 comprises the relatively richer Western European countries. Cyprus and Portugal form the second convergence club separate clearly from the more advanced

13Phillips and Sul (2007b) show in a series of Monte Carlo experiments that the log\((t)\) test attains good empirical size and power in finite samples, like the ones considered here.

14Several recessions occurred during the period under study, such as the first and second oil crisis of the 1970s, the ERM crisis of the 1990s and the recent global financial and economic crisis, which are predominantly captured in the cyclical component of the series. Yet, our objective is to describe the long-run evolution of the time series, while isolating dynamics at all other frequencies. Thus, we present empirical results from log\((t)\) regressions performed on time series filtered for business cycle fluctuations with the Hodrick and Prescott (1997) filter as suggested by Phillips and Sul (2007b). Filtering the data may have an impact on the empirical results and the choice of the business cycle filter is debatable. Therefore, we performed a series of robustness checks, including estimation on the raw series and on series filtered by a band-pass filter, and our main results have remained unchanged in that we have obtained similar club classification outcomes regardless of the applied technique. Nevertheless, the transition paths estimated from the Hodrick-Prescott filtered series retain a smooth, economically meaningful pattern, which constitutes a clear advantage compared to other methods.
Table 3.3: Convergence club classification: baseline results

<table>
<thead>
<tr>
<th>Sample: EU-21, 1970-2010</th>
<th>Club Countries</th>
<th>$t_b$</th>
<th>$\hat{b}(s.e.)$</th>
<th>$\hat{\alpha}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Sample</td>
<td></td>
<td>-7.308</td>
<td>-0.744 (0.102)</td>
<td>-0.372</td>
</tr>
<tr>
<td>Club 1</td>
<td>AUT, BEL, DEN, FIN, FRA, GER, GRE, IRE, ITA, MAL, NED, ESP, SWE, UK</td>
<td>7.730</td>
<td>0.325 (0.042)</td>
<td>0.163</td>
</tr>
<tr>
<td>Club 2</td>
<td>CYP, POR</td>
<td>1.333</td>
<td>0.557 (0.417)</td>
<td>0.278</td>
</tr>
<tr>
<td>Club 3</td>
<td>HUN, POL</td>
<td>4.025</td>
<td>2.400 (0.596)</td>
<td>1.200</td>
</tr>
<tr>
<td>Club 4</td>
<td>BUL, ROM</td>
<td>-0.590</td>
<td>-0.654 (1.109)</td>
<td>-0.327</td>
</tr>
<tr>
<td>Diverging</td>
<td>LUX</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample: EU-27, 1995-2010</th>
<th>Club Countries</th>
<th>$t_b$</th>
<th>$\hat{b}(s.e.)$</th>
<th>$\hat{\alpha}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Sample</td>
<td></td>
<td>-5.937</td>
<td>-0.437 (0.074)</td>
<td>-0.218</td>
</tr>
<tr>
<td>Club 1</td>
<td>AUT, IRE, NED, SWE</td>
<td>0.515</td>
<td>0.167 (0.325)</td>
<td>0.084</td>
</tr>
<tr>
<td>Club 2</td>
<td>BEL, DEN, EST, FIN, GER, SLO, UK</td>
<td>0.866</td>
<td>0.080 (0.093)</td>
<td>0.040</td>
</tr>
<tr>
<td>Club 3</td>
<td>CZE, GRE, ITA, LAT, LIT, SVK, ESP</td>
<td>0.631</td>
<td>0.075 (0.119)</td>
<td>0.038</td>
</tr>
<tr>
<td>Club 4</td>
<td>BUL, CYP, HUN, MAL, POL, POR</td>
<td>0.072</td>
<td>0.010 (0.142)</td>
<td>0.005</td>
</tr>
<tr>
<td>Diverging</td>
<td>FRA, LUX, ROM</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample: EU-21, 1995-2010</th>
<th>Club Countries</th>
<th>$t_b$</th>
<th>$\hat{b}(s.e.)$</th>
<th>$\hat{\alpha}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Sample</td>
<td></td>
<td>-8.481</td>
<td>-0.583 (0.069)</td>
<td>-0.291</td>
</tr>
<tr>
<td>Club 1</td>
<td>AUT, IRE, NED, SWE</td>
<td>0.515</td>
<td>0.167 (0.325)</td>
<td>0.084</td>
</tr>
<tr>
<td>Club 2</td>
<td>BEL, DEN, FIN, GER, UK</td>
<td>15.090</td>
<td>0.918 (0.061)</td>
<td>0.459</td>
</tr>
<tr>
<td>Club 3</td>
<td>GRE, ITA, ESP</td>
<td>4.409</td>
<td>1.630 (0.370)</td>
<td>0.815</td>
</tr>
<tr>
<td>Club 4</td>
<td>BUL, CYP, HUN, MAL, POL, POR</td>
<td>0.072</td>
<td>0.010 (0.142)</td>
<td>0.005</td>
</tr>
<tr>
<td>Diverging</td>
<td>FRA, LUX, ROM</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Log($t$) test results for convergence in real GDP per capita for the EU-27 sample for 1995-2010 and for the EU-21 sample for 1970-2010 and 1995-2010. Countries in bold are absent from the EU-21 sample (these are the Czech Republic, Estonia, Latvia, Lithuania, Slovakia, and Slovenia). The table contains the speed of convergence ($\hat{\alpha}$), the corresponding coefficient estimates ($\hat{b}$) and $t$-statistics. Newey-West standard errors are given in parentheses. The null hypothesis of convergence is rejected at the 5% level if $t_b < -1.65$. Clubs 2 and 3 of the EU-21 sample for 1970-2010 could be merged into an aggregate club that converges at a rate of $\hat{\alpha} = 0.021$.

EU countries. The estimated speed of convergence is $\hat{\alpha} = 0.163$ and $\hat{\alpha} = 0.278$ for clubs 1 and 2, respectively. Thus, the countries in both clusters undergo relative convergence in the observed period. We find absolute convergence in club 3 ($\hat{\alpha} = 1.200$), which implies that Hungary and Poland converge to a club-specific per capita real GDP level between 1970-2010. Further, note that the point estimate of $b$ in club 4 is negative ($\hat{b} = -0.654$) but not significantly different from zero, suggesting that Bulgaria and Romania form the weakest convergence club. Turning to Figure 3.3/(b), the average transition curve for club 1 is flat, providing further evidence that the highly developed countries have
3.5. Empirical results

Figure 3.3: Relative transition paths

Note: (a) Relative transition curves for EU-21 countries. (b) Average relative transition curve for each convergence club. Club 1: AUT, BEL, DEN, FIN, FRA, GER, GRE, IRE, ITA, MAL, NED, ESP, SWE, UK. Club 2: CYP, POR. Club 3: HUN, POL. Club 4: BUL, ROM.

been growing at a slower rate on average compared to the rest of the panel. The average transition curves of club 2 and the CEEC that constitute clubs 3 and 4 show that these relatively poorer countries have been unable to catch up with the more developed West over the long horizon, in spite of a salient upswing starting from the mid-nineties.

Regarding our analysis for the EU-27 (and EU-21) sample for 1995-2010, only relative convergence is detected, implying that within each club relative income differentials tend to decrease over time.¹⁵

¹⁵Notice that the results are robust to omitting the 6 CEEC from the short panel.
The three diverging countries are France, Luxembourg, and Romania. Based on the transition curves for the shorter sample, the general picture remains unchanged in that the wealthier Western European countries (clubs 1 and 2) are mainly on higher transition paths, while most of the post-communist economies (clubs 3 and 4) tend to cluster below the EU average. Figure 3.3 hints at the evolution of transition curves between 1995-2010, we thus omit plotting them in order to save space.

The middle panel of Table 3.3 highlights some interesting results. Some of the CEEC have been catching up, while certain Western economies have experienced a slowdown when focusing on the short panel. On the one hand, Estonia and Slovenia converge to a group of more developed countries and form club 2 together with Belgium, Denmark, Finland, Germany, and the UK. This finding may be attributed to the vigorously pursued economic reforms and integration with the West after gaining independence in 1991 (see Svejnar, 2002; Adam, Kristan and Tomsic, 2009). On the other hand, three of the four major Mediterranean countries (Greece, Italy, and Spain) belong to club 3 alongside the Czech Republic, Latvia, Lithuania, and Slovakia. The remaining Mediterranean countries (Cyprus, Malta, and Portugal) form the subgroup with the relatively lowest real income level per person, together with Bulgaria, Hungary, and Poland. Thus, we observe a gradual setback of Mediterranean countries, resulting in a South-East vs. North-West separation of European economies by the mid-nineties, which supports the idea that countries tend to cluster on the basis of geographic region.

3.5.2 Patterns of economic transition

European countries introduced several policies with the aim of achieving economic integration, including the liberalization of goods, capital, and labor markets, harmonization of tax policy, and the foundation of the EMU. Empirical studies have shown that stronger integration promotes catching-up and convergence in the long run (see, e.g., Crespo Cuaresma et al., 2008). Our results provide statistical evidence that the process of European economic integration is yet unfinished, in that EU countries do not converge to the same real per capita income level. In this subsection, we examine the evolution of convergence and clustering in a number of subsample analyses, and we illustrate the typical patterns of economic transition in the EU over the last 40 years. Our aim is to determine

16With the exception of clubs 2 and 3 of the EU-21 panel for 1970-2010, there is no evidence to support merging of the neighboring clubs. The aggregate of clubs 2 and 3 converges at a rate of $\hat{\alpha} = 0.021$.

17The existing literature suggests that separation of countries into distinct convergence clubs may occur due to differences in initial conditions as well as structural characteristics. Bartkowska and Riedl (2012) have shown by means of logistic regressions that starting conditions are important determinants of club membership, while structural characteristics play a relatively minor role. Although potentially interesting, performing a comparable regression analysis at the country level is inhibited by the small size of our sample (27 countries instead of 206 regions).
Table 3.4: Convergence club classification: subsample results

Sample: EU-21, 1980-2010

<table>
<thead>
<tr>
<th>Club</th>
<th>Countries</th>
<th>$t_b$</th>
<th>$b(s.e.)$</th>
<th>$\hat{\alpha}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Sample</td>
<td></td>
<td>-4.704</td>
<td>-0.539 (0.115)</td>
<td>-0.270</td>
</tr>
<tr>
<td>Club 1</td>
<td>AUT, BEL, DEN, FIN, FRA, GER, GRE</td>
<td>-1.428</td>
<td>-0.042 (0.029)</td>
<td>-0.021</td>
</tr>
<tr>
<td></td>
<td>IRE, ITA, NED, ESP, SWE, UK</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Club 2</td>
<td>CYP, HUN, MAL, POL, POR</td>
<td>1.308</td>
<td>0.519 (0.397)</td>
<td>0.260</td>
</tr>
<tr>
<td>Club 3</td>
<td>BUL, ROM</td>
<td>-0.013</td>
<td>-0.008 (0.625)</td>
<td>-0.004</td>
</tr>
<tr>
<td>Diverging</td>
<td>LUX</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sample: EU-21, 1990-2010

<table>
<thead>
<tr>
<th>Club</th>
<th>Countries</th>
<th>$t_b$</th>
<th>$b(s.e.)$</th>
<th>$\hat{\alpha}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Sample</td>
<td></td>
<td>-5.424</td>
<td>-0.439 (0.081)</td>
<td>-0.219</td>
</tr>
<tr>
<td>Club 1</td>
<td>AUT, BEL, FIN, IRE, NED, SWE, UK</td>
<td>0.729</td>
<td>0.066 (0.090)</td>
<td>0.033</td>
</tr>
<tr>
<td>Club 2</td>
<td>DEN, FRA, GER, GRE, ITA, POL, ESP</td>
<td>1.118</td>
<td>0.134 (0.120)</td>
<td>0.067</td>
</tr>
<tr>
<td>Club 3</td>
<td>BUL, CYP, HUN, MAL, POR, ROM</td>
<td>0.355</td>
<td>0.065 (0.184)</td>
<td>0.033</td>
</tr>
<tr>
<td>Diverging</td>
<td>LUX</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sample: EU-27, 2000-2010

<table>
<thead>
<tr>
<th>Club</th>
<th>Countries</th>
<th>$t_b$</th>
<th>$b(s.e.)$</th>
<th>$\hat{\alpha}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Sample</td>
<td></td>
<td>-11.348</td>
<td>-0.663 (0.058)</td>
<td>-0.331</td>
</tr>
<tr>
<td>Club 1</td>
<td>AUT, BEL, IRE, NED, SWE</td>
<td>1.337</td>
<td>0.236 (0.176)</td>
<td>0.176</td>
</tr>
<tr>
<td>Club 2</td>
<td>DEN, FIN, GER, UK</td>
<td>3.700</td>
<td>1.196 (0.323)</td>
<td>0.323</td>
</tr>
<tr>
<td>Club 3</td>
<td>CZE, FRA, GRE, ITA, SVK, SLO, ESP</td>
<td>1.030</td>
<td>0.164 (0.159)</td>
<td>0.159</td>
</tr>
<tr>
<td>Club 4</td>
<td>CYP, EST, HUN, LAT, LIT, MAL, POL, POR</td>
<td>2.129</td>
<td>0.236(0.111)</td>
<td>0.111</td>
</tr>
<tr>
<td>Diverging</td>
<td>BUL, LUX, ROM</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Log($t$) test results for convergence in real GDP per capita for the EU-21 sample for 1980-2010 and 1990-2010, and for the EU-27 sample for 2000-2010. Countries in bold are absent from the EU-21 sample (these are the Czech Republic, Estonia, Latvia, Lithuania, Slovakia, and Slovenia). The table contains the speed of convergence ($\hat{\alpha}$), the corresponding coefficient estimates ($\hat{b}$) and $t$-statistics. Newey-West standard errors are given in parentheses. The null hypothesis of convergence is rejected at the 5% level if $t_b < -1.65$. Merging of the neighboring clubs is rejected in all subsamples considered.

whether there is a potential for relatively poorer economies to reduce the gap with wealthier countries (and vice versa), and to identify the transition paths along which this catching-up can be achieved over time.

Table 3.4 shows the club classification results for the EU-21 for the sub-periods between 1980-2010, 1990-2010, and for the EU-27 between 2000-2010. On balance, the clustering patterns in the subsamples resemble important similarities with our baseline club classifications, and therefore they confirm the robustness of our main results. The differences between convergence and clustering in each subsample and the longer baseline panel come from the fact that income dispersion was relatively
high at the initial period and has significantly reduced by the end of the century. Consequently, economies that converge over the period from 1970 till 2010 do not necessarily form the same cluster when considering panels that begin at a more recent date (i.e., 1980, 1990, and 2000).

Table 3.3 and Table 3.4 also reveal some evidence on the underlying transition across clubs over time. In particular, club 1 from the long panel of Table 3.3 splits gradually into the richest four (Austria, Ireland, the Netherlands, and Sweden), a second group of wealthy economies (Belgium, Denmark, Finland, Germany, and the UK), and a third group comprised of three Mediterranean countries (Greece, Italy, and Spain). The second group forms a new club together with the higher-income Estonia and Slovenia by 1995, while the Mediterranean countries are joined by four CEEC (the Czech Republic, Latvia, Lithuania, and Slovakia). Further, club 2 (Cyprus and Portugal) and club 3 (Hungary and Poland) – together with Malta from club 1 – of the long panel start forming the same (relatively poorest) convergence club from 1980 onwards, as shown in Table 3.4. This club is complemented with Bulgaria and Romania by the early 1990s, even though Romania is among the diverging countries in 1995, followed by Bulgaria in 2000. Finally, the Baltic countries (Estonia, Latvia, and Lithuania) join the least wealthy club by 2000, and Slovenia also falls behind the richer Western economies lately.

We provide further insights on the transitional dynamics observed in a split-sample analysis. Given the importance of the new member states in the European economic integration process, we have divided the sample accordingly to the fall of the socialist system into a period spanning from 1970 to 1989 and a period between 1990 and 2010. The results (Table 3.5) are in line with the previous findings in that the CEEC countries separate from the rest of the economies in all subperiods considered. In addition, it is interesting to see that the Mediterranean countries that joined the EU in the 1980s (Greece, Portugal, and Spain) were unable to catch up with the more developed Western economies shortly after accession and form a second convergence club together with Ireland. The economy of Ireland was characterized by slow growth, high inflation, and increasing public debt by the early eighties. However, the economic and public sector reforms – facilitated by EU Structural Funds – in the late 1980s contributed to a catch-up and continuous growth over the last 20 years. Besides, Ireland’s favorable performance was further stimulated by a rise in consumer spending, a huge inflow of foreign direct investment, and the transformation into an export-orientated economy (European Commission, 2008). Hence, such developments enabled Ireland to join the relatively richest

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18A decline in per capita real income in Germany can be attributed to the reunification in 1990 (see Canova and Ravn, 2000).
19Clubs 1 and 2 of the period between 1970 and 1989 could be merged into a single aggregate subgroup that converges in a relative sense.
3.5. Empirical results

<table>
<thead>
<tr>
<th>Sample: EU-21, 1970-1989</th>
<th>Club</th>
<th>Countries</th>
<th>( t_\hat{b} )</th>
<th>( \hat{b}(s.e.) )</th>
<th>( \hat{\alpha} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Sample</td>
<td></td>
<td></td>
<td>-19.281</td>
<td>-0.492 (0.025)</td>
<td>-0.246</td>
</tr>
<tr>
<td>Club 1</td>
<td>AUT, CYP, DEN, FIN, GER, ITA, MAL, NED, SWE, UK</td>
<td>3.884</td>
<td>0.177 (0.046)</td>
<td>0.089</td>
<td></td>
</tr>
<tr>
<td>Club 2</td>
<td>GRE, IRE, POR, ESP</td>
<td>0.349</td>
<td>0.042 (0.119)</td>
<td>0.021</td>
<td></td>
</tr>
<tr>
<td>Club 3</td>
<td>BUL, HUN, POL, ROM</td>
<td>4.349</td>
<td>0.091 (0.021)</td>
<td>0.045</td>
<td></td>
</tr>
<tr>
<td>Diverging</td>
<td>BEL, FRA, LUX</td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample: EU-21, 1990-2010</th>
<th>Club</th>
<th>Countries</th>
<th>( t_\hat{b} )</th>
<th>( \hat{b}(s.e.) )</th>
<th>( \hat{\alpha} )</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
<td></td>
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<td>-0.219</td>
</tr>
<tr>
<td>Club 1</td>
<td>AUT, BEL, FIN, IRE, NED, SWE, UK</td>
<td>0.729</td>
<td>0.066 (0.090)</td>
<td>0.033</td>
<td></td>
</tr>
<tr>
<td>Club 2</td>
<td>DEN, FRA, GER, GRE, ITA, POL, ESP</td>
<td>1.118</td>
<td>0.134 (0.120)</td>
<td>0.067</td>
<td></td>
</tr>
<tr>
<td>Club 3</td>
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<td>0.355</td>
<td>0.065 (0.184)</td>
<td>0.033</td>
<td></td>
</tr>
<tr>
<td>Diverging</td>
<td>LUX</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Log(\( t \)) test results for convergence in real GDP per capita for the EU-21 sample for 1970-1989 and 1990-2010. The table contains the speed of convergence (\( \hat{\alpha} \)), the corresponding coefficient estimates (\( \hat{b} \)) and \( t \)-statistics. Newey-West standard errors are given in parentheses. The null hypothesis of convergence is rejected at the 5% level if \( t_\hat{b} < -1.65 \). Clubs 1 and 2 of the subperiod 1970-1989 could be merged into an aggregate club that converges at a rate of \( \hat{\alpha} = -0.090 \).

subgroup in the second subperiod. In contrast, Malta belongs to club 1 during the period 1970-1989, but exhibits a significant setback and forms club 3 together with the CEEC, Cyprus, and Portugal afterwards. The rapid economic growth of Malta until the late nineties was driven by a combination of favorable economic climate and a change in the policy orientation. High domestic and external demand, significant inflows of foreign direct investment, trade liberalization, reduction in income and corporate tax rates, privatization in sectors including financial services and telecommunications have all contributed to Malta’s catching-up process (see Montfort, 2002; Farrugia, 2004).

One considerable advantage of the technique employed here is that, unlike other methodologies, it allows for heterogeneity and transitional divergence of individual transition paths. In practice, Phillips and Sul (2009) distinguish between a variety of transition paths that stem from cross-sectional heterogeneity of individual country characteristics. Such trajectories include (i) relative transition paths that converge to unity from an either high or low state of departure, (ii) an initial period of divergence (labeled transition phase A) followed by a catch-up phase (phase B) and later convergence (phase C), and (iii) divergence from the panel toward a state below (\( h_{1T} < 1 \)) or above (\( h_{1T} > 1 \)) unity.
Figure 3.4 illustrates the transition curves of all countries belonging to the first convergence club from the 1970-2010 panel. We focus on this club because it provides a good basis to study different shapes of economic transition. Note that $h_{it}$ refers here to the transition path of each country relative to all other countries in club 1. As one can see from the figure, countries with superior income levels further split in the last fifteen years. Despite belonging to the same club in the long panel, Austria, Ireland, and the Netherlands manifest transition curves above the rest between 1995-2010. On the other hand, the transition paths of the three major Mediterranean countries (Greece, Italy, and Spain) part from the richer EU economies if we consider a more recent period. Thus, the separation scheme described previously is clearly reflected in Figure 3.4.

The most remarkable type (i) transition curve is displayed by Malta which started from the lowest state in club 1, and achieved a huge rise in real GDP per capita between the 1970s and 1990s. A good example for type (ii) transition is displayed by Ireland, which was in phase A until the early 1980s, however, it managed to turn its performance during the 1980s (phase B) and exhibited a spectacular catching-up and convergence period (phase C) by the beginning of the 21st century. Malta and Ireland illustrate best the paths along which there is a potential for initially poor countries to reduce their income disparity relative to richer economies in the long run. Other examples of type (i) transition include Austria, Denmark, the Netherlands, and Sweden, while Finland, Greece, Italy, Spain, and
the UK are good examples of type (ii) transition. Furthermore, the transition dynamics of the CEEC are of the second type as well. According to Figure 3.3, each of these countries were simultaneously on diverging transition paths by the 1980s, – indicating the decline of the socialist economic system – which was followed by a notable catch-up as result of the macroeconomic adjustment processes that started in the nineties. Finally, Luxembourg is an obvious type (iii) country, i.e., diverging throughout the entire sample period.

### 3.6 Concluding remarks

In this chapter we analyze per capita real income convergence in the European Union between 1970 and 2010. We employ a convergence test derived from a neoclassical growth model augmented with endogenous technological progress which differs across countries and over time (Phillips and Sul, 2007b). The test is applied in an iterative manner in order to identify convergent country groups. Following this econometric approach, we establish a set of novel stylized facts on the evolution of economic convergence over the last 40 years.

Our findings can be summarized as follows. First of all, there is no overall income convergence in the EU, and this result is robust to any time horizon considered. Instead, we detect subgroups that converge to different steady-state equilibria. The clubs are formed mainly on the basis of geographic region. Yet, eurozone countries belong to distinct subgroups, thus clustering is not necessarily related to EMU membership. Moreover, there is a clear separation between the CEEC and the old EU members in the long run, suggesting that, even though the CEEC have exhibited higher real income growth than the EU average over the last 40 years, catching up was not sufficient in order to eliminate cross-country real income per capita differences. Finally, we observe a South-East vs. North-West division of European economies by the mid-nineties.

Our results draw attention to the lack of growth-enhancing structural reforms in EU countries, posing a threat to the achievement of real convergence in the near future. Moreover, despite the fact that the CEEC economies went through profound changes starting from the early nineties, indicating some degree of convergence toward the West, policymakers should consider the persistent differences documented in this study in the light of further enlargement of the European Union.
### 3.7 Appendix A: Clustering algorithm

To identify convergence clubs we use the following clustering algorithm proposed by Phillips and Sul (2007b):

**Step 1 Last observation ordering**: Order the $N$ countries in the panel according to the last observation $y_{iT}$.

**Step 2 Core group formation**: Form all possible subgroups $G_k$ by selecting the first $k$ highest units for $2 \leq k < N$. Run the log($t$) regression to obtain the test statistic $t_b$ for each subgroup $k$. Define the core group of size $k^*$ by maximizing $t_b$ subject to $\min t_b > -1.65$. This maximization rule reduces the probability of a type II error. If the condition $\min t_b > -1.65$ does not hold for $k = 2$, drop the first country in the panel and repeat the same procedure for the rest. Continue until a subsequent pair of units is detected with $t_b > -1.65$ and a core group $G_k^*$ can be formed. If no such pair is found then conclude that there are no convergence clubs in the panel. In addition, note that if $k^* = N$ all units converge.

**Step 3 Sieve individuals for club membership**: After the core group is detected, add one of the remaining units at a time and run the log($t$) regression for each. Include the unit in the subgroup if the corresponding test statistic $t_b$ is greater than some critical value $c^*$.20 Once all units satisfying the sieve criterion are added, run the log($t$) test for the subgroup. If $t_b > -1.65$, a convergence club is formed, otherwise raise the critical value $c^*$ – to increase the degree of conservativeness of the test – and repeat the procedure until $t_b > -1.65$ for the entire group. Then conclude that the group constitutes a convergence club. If no remaining units can be sieved to the initial core group, the group itself constitutes a club.

**Step 4 Recursion and stopping rule**: Form a second group from all countries that could not be sieved in Step 3 and run the log($t$) test again. If the whole group converges, i.e. $t_b > -1.65$, conclude that there are two convergence clubs in the panel. If not, repeat Steps 1-3 on the same group to determine whether there are any smaller subgroups that form convergence clusters. If no other clubs can be detected, conclude that the remaining countries diverge.

**Step 5 Club merging**: Run log($t$) regressions to test for convergence across each subsequent group. If the $t$-statistic is greater than $t_b > -1.65$, merge the associated clusters into a larger club.

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20Phillips and Sul (2009) suggest to set the sieve criterion $c^* = 0$ when $T$ is small ($T \leq 50$), whereas for large $T$ the usual critical value $-1.65$ can be employed.
This additional step is necessary, given that by increasing the critical value $c^*$ the clustering procedure becomes highly conservative, leading to a tendency to detect more convergence clubs than the true number. Finally, add the group of diverging units to each cluster separately and run the log($t$) test again.

### 3.8 Appendix B: Real income per capita in the EU-27

#### Table 3.6: Real income per capita in the EU-27

<table>
<thead>
<tr>
<th>Country</th>
<th>1970</th>
<th>1995</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Luxembourg</td>
<td>23111.007</td>
<td>51367.205</td>
<td>75589.760</td>
</tr>
<tr>
<td>Austria</td>
<td>15743.317</td>
<td>29356.418</td>
<td>38585.630</td>
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<tr>
<td>Netherlands</td>
<td>19581.641</td>
<td>29514.920</td>
<td>38189.654</td>
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<td>Sweden</td>
<td>19548.956</td>
<td>25667.433</td>
<td>36132.559</td>
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<td>Belgium</td>
<td>15679.025</td>
<td>27822.912</td>
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<tr>
<td>Ireland</td>
<td>10953.969</td>
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<td>34902.262</td>
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<tr>
<td>United Kingdom</td>
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<td>24707.670</td>
<td>34266.968</td>
</tr>
<tr>
<td>Germany</td>
<td>16483.607</td>
<td>28473.073</td>
<td>34085.346</td>
</tr>
<tr>
<td>Denmark</td>
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<td>33716.831</td>
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<tr>
<td>Finland</td>
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<td>22967.100</td>
<td>32991.911</td>
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<tr>
<td>France</td>
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<td>26491.975</td>
<td>31299.300</td>
</tr>
<tr>
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<td>26155.285</td>
<td>28380.924</td>
</tr>
<tr>
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<td>21504.875</td>
<td>27332.008</td>
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<td>25225.516</td>
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<td>24901.650</td>
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<td>21851.198</td>
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<td>16340.401</td>
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<td>Slovakia</td>
<td>n.a.</td>
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<tr>
<td>Cyprus</td>
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<td>Poland</td>
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<tr>
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<td>n.a.</td>
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<td>Romania</td>
<td>2910.499</td>
<td>5620.943</td>
<td>9376.188</td>
</tr>
</tbody>
</table>

**Note:** PPP-converted GDP per capita at 2005 constant prices (in USD) for the first (1970 for EU-21 and 1995 for EU-27) and last observation (n.a. refers to missing observations). Countries are listed in descending order on the basis of 2010 GDP per capita.
Bibliography


