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**Macroeconomic Fluctuations in Emerging and Developing Economies**

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sous la direction de M. Jean-Pierre ALLEGRET (Université de Nice)

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Now is the winter of our discontent,
Made glorious summer by this sun of York;
And all the clouds that lour’d upon our house
In the deep bosom of the ocean buried.


Starting out my PhD back in late 2014, I was not expecting the kaleidoscope of events, emotions and experiences that washed over me since then. I underwent a humbling process, one whose teachable moments are sure to stay with me for what I hope to be my academic career. I like to think there was more to learn than just what was needed to write a dissertation. Yet I beg the reader’s indulgence to set aside the writing standards of academe to share my thanks and acknowledgments. For better or worse, I still write in a style frequently at odds with the arcane rules of academic writing, and I suspect I will learn its esoteric ways, yet. I will confess that writing this dissertation has not been easy, nor pleasant at times. If anything, it was an intensely lonely endeavour, in a way not unlike the lyrics of any song by Simon & Garfunkel. Indeed the work has, at times, been tedious and repetitive with no end or resolution in sight. In many ways, it is quite like hitting a brick wall multiple times, hoping against hope it would give way.

Yet the writing process as been for me a study of paradox. Though the loneliness of research and writing one’s dissertation can be suffocating, talking to other people with similar issues - or who are familiar with the ordeal, was a boon. My colleagues and my parents may not have been aware of it, but the frequent chats, tea breaks and social gatherings have been a therapy of sorts. I will be forever in their debt for being there for me in moments of self-doubt and low morale, of which there were many. I am glad I had the opportunity to do my PhD in a friendly research laboratory. In sharing what I am sure to be the lot of my fellow PhD candidates, and with the kind and encouraging words of assistant professors, full professors and support staff, I have learned to better myself, to understand the purpose of my research and the importance of life outside research and teaching. I am sure I have been a slow learner, but a keen one nonetheless.

Although defending my thesis should be a happy event, I cannot put it out of my mind that one person who will not attend the happy conclusion of my travails. My father has passed away in late April 2018, and to my sorrow, I feel as though I have let him down. I am fortunate enough to have had loving and caring parents who have gone above and beyond in providing me with the best education they could afford, and then some. They have offered nothing but full support for my application to get into the PhD programme at Nanterre University. This is why I am sad father will not attend a crowning achievement of his unflinching lifelong support. I have not only lost a caregiver, I have also lost a confident, someone with whom conversation is always stimulating and engaging. I am left with memories to remember, working backward from the last vacation we have spent together in Summer 2015, all the way to the 1980s, when I was a toddler in his care. Nevertheless, I find solace in the fact that mother will be attending. I hope she will see the thesis defence as an achievement of all the efforts and sacrifice she and
father have made to get me where and what I am today. I am truly blessed to have such parents, and I hope mother will see this dissertation as a token of gratitude for been what she is. I would be remiss not to mention all the workload mother had to take on to make sure I had always a first-class education and access to learning material. She has always been soothing in times of great self-doubt, low morale and periods of general funk.

In the research lab, my supervisor, Prof. Jean-Pierre Allegret has been steadfastly supportive of my work with his comments, observations and critique of my research. I can say it with some measure of confidence that I have regularly tested his forbearance to its limit, yet I have never found his wanting. I am in his debt not only for all the time he had edited my ramblings into coherent content, but also grateful for the emotional support he has provided whenever I was rejected from conferences, workshops and paper submissions to academic journals – heaven knows there were many of those. After he moved to Nice, there were countless times we worked on this manuscript over Skype at 8:00 am. While still at Nanterre, Jean-Pierre has been kind enough to give me leeway in reworking teaching material for recitations and problem sets. I have learnt so much about teaching by editing the material for the undergraduate macroeconomics course, some experience that I am sure will be handy later on. I was also happy to note that we shared a common interest in the weird tales of one H.P. Lovecraft. I shall conclude my thanks by quoting from that doomed incantation: Ph’nglui mglw’nafh Cthulhu R’lyeh wgah’nagl fhtagn.

The reader will not be surprised to know that I have hit a few speed bumps before I could defend my thesis, originally scheduled for early April 2018. At that particularly low moment of my time at EconomiX, I have to thank my boss and leader of the EconomiX research lab, Prof. Valérie Mignon. Upon hearing about it, she was kind enough to have taken the time to give me a pep talk after a rather harrowing day at the T2M conference - Paris Dauphine university. Valérie was kind enough to wait late afternoon for me to return to Nanterre, and talk about it for well over an hour. Right until the end, she has regularly asked about how work was going, and how was my morale. Prof. Cécile Couharde was also present that day, and gave me invaluable support and warm encouragements as well. As a member of my dissertation thesis committee, she has also been very supportive at a time when my sense of self-worth was very low. In agreeing to reach and edit my revised manuscript, she has accepted to undertake additional duties she did not have to, to my benefit. For that and for many other things that I do not care to enumerate, I am immensely grateful to both. Another professor who has been of great help, and very much was engaged in mentoring is Prof. Ludovic Julien. I fail to count the number of times when his advice as to references of books and papers has been sound. Since my Master’s, Ludovic has been a wealth of information, advice and resources I could draw upon. I am also grateful that he regularly invited me to the Strategic Interactions & General Equilibrium workshop, three years in a row. My thanks go beyond the professional curtesy they have extended to me throughout these years. There was a measure of human kindness that have made it all not only bearable, but prompts enthusiasm to get involved in EconomiX activities.

My office G602 is located on the sixth floor of the Maurice Allais building. Among my neighbours are some of the best people in EconomiX, and I am sure, in academe. I am grateful to Gilles de Truchis and Karine Constant (Paris-Crétteil University) for so many things that would barely fit in this section. They have always been generous with smart and pertinent advice when it comes to post-PhD careers. They shared experiences in navigating the minutiae of the application process to academic posting, as well as the importance of publications in peer-reviewed journals. And because they are such wonderful human beings, I always have a blast when we go out to see the movies. Gilles was once kind enough to invite me to a concert by Avishai Cohen, in an evening that was quite the musical education. Gilles shares his office with Elena Dumitrescu, with whom I have had lunch almost every day since 2015. In addition to being a first-rate academic with a stellar career, Elena is a wonderful cook, tailor, gardner and handy with almost anything else. A Jack of all trades and master of them all, I can only
hope to imitate her work ethics in and out of academe.

At the start of the Fall semester of 2015, I joined fellow PhD candidates Stellio Del Campo and Penda Sokhna in organising the bi-monthly brownbag PhD workshop. Every other Thursday, fellow PhD candidates have an opportunity to present their papers for discussion, and to get feedback. Though it is a small-scale organisation, it takes a lot of work, and I was fortunate in having Stellio and Penda, then other colleagues take over as years went by. I got used to work with colleagues and friends in hunting down volunteers to present their papers all year round. That is how I got to know so many of my colleagues in their respective offices in G209, G301, G313 and G601. My own G602 office was/is a great place. Good people have gone through G602 - I have to thank Silvia Concettini (François Rabelais University - Tours) for putting up a poster with Alice in Wonderland with the caption ‘We’re all mad here’ - as I am sure we are indeed. Alzbeta Mangarella-Mullerova (IOS Regensburg) and Juliana Milovich have been great friends and colleagues, who sat cross my desk. The G602 becomes livelier on Thursday, thanks to Lauren Stagnol, Déborah Leboullanger, George Overton, Sandrine Lecarpentier and Anthony Paris. Leonore Raguideau-Hannotin whom I got to know and appreciate for her moral support in the moral troughs, and whom I credit for the phrase: ‘Force & Honneur !’, a motto I would very much like make my own. My office is also very fortunate to have a resident student body representative, Dalia Ibrahim. I am sure all remember going out to eat at her suggestion in Japanese restaurant near Opéra in December 2017. I must also thank my co-author Lesly Cassin for her kindness and infinite patience with my procrastination, and must remember to make myself more available for drinks. I must mention Omar ‘Pap’ Sène (University Alioune Diop - Senegal) who was a Postdoctoral fellow at EconomiX, interns Inessa, Yoan, Sarah, Fanny and Capucine. I hope they have enjoyed the experience at the research lab, picked up some skills and have not been deterred from embarking in academe.

These past four years I have tried as much as I could to board the RER A line early in the morning on off-peak hours. That means going to EconomiX early in the morning, where I have my morning tea with Gilles, Nasam Zeroualet and Fred Lebiet. Other members of the support staff are also great company, like Abdou Rabba, Messaoud Zouikri and Alin Thrin-Sky. Xi Yang has left for China earlier this year, and I feel sad she is no longer with us at EconomiX. Henrique Rodas my neighbour and some time bike riding partner, whose optimistic outlook always bucks me up when I am down. I would also like to thank Frédéric Hammerer, whose dourness hides a competent administrator who runs the trains on time. I have not found him lacking whenever I was preparing to travel for a conference, or when I needed to make sure I had all necessary ECTS credits to complete my PhD requirements. Frédéric is ably assisted by Catherine Héréüs, Véronique Robin and Alinh Rin-Tybenszky, who have always dispatched with great speed whatever request I had. Béatrice Silva and Jocelyne Barre have left some time ago, and I want to thank them as well.

During my PhD I was fortunate enough to attend conferences, workshops and summer schools. Although I am a bit miffed at being rejected from so many of those, I still had great feedback from participants of the 2016 WERI conference in Barcelona and the Scottish Economic Association annual Meeting at Perth, Scotland. I also had good discussions at the 65th AFSE conference in Nancy, and then the next year at Nice for the 66th AFSE meeting. I was also very fortunate to attend the 2018 Royal Economic Society meeting at Brighton (Young Researchers) and the 2018 CEF meeting in Milan. The summer schools I have attended in 2016 and 2017 have been great opportunities to meet and talk to economists of great renown. At the Barcelona Gradual School 2016 Summer School, Prof. Jordi Gali (CREI-BGSE) is thanked for his comments on a chapter of my manuscript, and for his autograph. During the 2016 Summer Methods Programme at the London School of Economics, Prof. Wouter Den Haan (CEPR-LSE) has been generous with his time in tackling in-depth about the same model, and confirming the soundness of its basic assumptions. Comments offered by Prof. Mark Aguiar (Princeton) at the
2017 Gerzensee Summer School were very helpful as well. More recently, I was very happy to meet with Prof. Pierre-Richard Agénor (University of Manchester) when he was visiting scholar at our lab. I managed to get his autograph for his book with Peter J. Montiel, a regular fixture in my research – and was dazzled by how far he goes in his mind and his research interest. All of this could not have been possible without the full financial support of EconomiX-Paris Nanterre University, for which I am grateful. I have relied a lot on funding from my research lab to travel and attend conferences and summer schools, and I would not have improved on my research without the support and encouragements of Valérie, Jean-Pierre and the EconomiX board.

I used to have other areas of interest beside academe, once. Christophe Guguen and Ali Amar have launched LeDesk.ma, the online Moroccan news outlet in 2015, and I was invited to write pieces there as a data-journalist on Moroccan economic and political news. I am grateful to them both for giving me access to a great medium in which I wrote about economics and politics, with a great deal of freedom in choosing the topics I was interested in. I am particularly proud of the work done on fact-checking government communiqués and the PR campaign they have launched before the October 2016 general election, electoral manifestos for a half-dozen political parties, and a small statistical model I had developed to forecast results in terms of share of seats and votes. It was quite the coup to forecast the results with great accuracy. In late 2015, the Heinrich-Böll-Stiftung foundation was kind enough to invite me to participate in a workshop in Chefchaouen and Marrakesh, Morocco, as well as a study trip in Berlin at HBS headquarters. I have had the pleasure to meet and talk to Zainab El Guerrab, Soufyane Fares, Kaja Weldner, Anja Hoffmann and HBS Rabat-North Africa director Dorothea Rischewski. I have fond memories of a fun trip from Chefchaouen to Marrakesh on the HBS mini-bus that took twice as long through Beni-Mellal and the hinterlands of the Atlas mountains, as though we were stuck in some time-warp. Financial support from the HBS foundation is gratefully acknowledged in writing and publishing a report on the ecological assessment of the 2016 electoral manifestos in Morocco. The report was presented and discussed at the COP23 in Marrakesh, November 2016. In the rapidly shrinking circle of non-academic acquaintances, I have to thank Nicole Cunningham for her kindness and readiness to lend a hand in so many ways. A true bilingual Ole’Miss graduate, she has generously offered to edit my manuscript and share her comments on form and writing style. Her contributions did extend beyond editing to moral support, and generally being a dear friend with whom conversation is always sparkling, though dank memes were exchanged.

In 2017, due to administrative changes in my contract, I had to take on more teaching duties. Jean-Pierre had also left for Nice, so the very able Pauline Gandrè has replaced him in teaching the Macroeconomics course for third year undergraduates. Pauline has been a great colleague and lecturer, who was not given to micromanage the recitation sessions. I can only hope I was not excessively zealous about teaching and preparing the problem sets, and have been able enough to support in her workload. I must also thank Hamza Bennani for his likewise light-touch management for his first-year master course. Both have been great colleagues who have shown compassion and kindness at times of stress and personal loss. Like so many other colleagues, they have been generous with their time to listen to me gripe, and have given freely smart advice and comments on my research. The prep session for my defence committee that took place early April 2018 has been a teachable moment. I will not dissemble in saying that it was not stressful or disheartening to be submitted to in-depth critique of my work for a little over four hours. The referees, Lise Patureau (Dauphine University) and Fabien Tripiet (Evry University) were nothing but thorough in their comments, and did not spare effort or time to review and critique my manuscript. I like to think that thanks to their uncompromising critique, I am a better PhD candidate for it. Tepthida Sopraseuth (Cergy University) is also gratefully acknowledged for pointing out a promising area in rewriting a chapter of my manuscript. I thank Jean-Bernard Chatelain (Paris I Panthéon-Sorbonne University) is also thanked for accepting to sit on the committee. Academe is a highly demanding field, and I entered the PhD programme
with my eyes wide open about it. I only hope that this manuscript has risen to the standards set by the PhD committee members. I am also aware that I have left out so many people out to thank. It would have been next to impossible to finish this dissertation without the constant support and help from all those mentioned above, and those that are not. The would know that I am in their debt for making this happen.

Finally, I would like to close with a favorite quote of mine, one that I have as a motivational poster pasted on a wall in my G602 office. A celebrated line from William Shakespeare’s play ‘Henry V’ (Act 3 - Scene 1) spoken by the eponymous King while storming the walls of Harfleur during the Hundred Years War:

"Once more unto the breach, dear friends, once more; or close the wall up with our English dead."
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Chapter 1

Introduction and outline

1.1 Introduction

Why has the literature neglected for so many years the study of macroeconomic fluctuations in emerging economies? Answers to this question fall into two broad categories. The first is methodological and grounded in the dominant theoretical framework first used to delineate the macroeconomic properties of these countries. The second concerns itself with empirics, namely the constraints imposed by data quality and availability.

One prominent argument can be made that economic growth issues in those economies take precedent, in view of its welfare-enhancing effects on economic agents in those economies. There is merit to the focus on growth as the best way to improve welfare, instead of smoothing the cycle altogether. Such an argument is explicitly made by Lucas [1990, 2003] and Lucas and Gillman [2013]. They show that there are only trivial gains to be expected from permanent consumption levels when the business cycle is completely eliminated. Conversely, even a small decline in the steady-state consumption growth generates a substantially higher adverse impact on welfare. Nevertheless, a more recent body of the literature has shown that as far as emerging economies are concerned, there are substantial gains to be made from cycle-smoothing policies. Reis [2009] shows that under alternative specifications of exogenous shocks on households’ consumption path, welfare gains from increasing steady-state consumption growth can be substantial. Still, the methodological objections do not pass muster. The Lucas [1990, 2003] estimation of welfare gains from cycle smoothing are criticised in the subsequent literature. Such a criticism is reported in Krusell et al. [1998], namely the possibility that while trend output may be unaffected, some assumptions about preferences, and more particularly about the stochastic process that defines consumption may be discussed. Such a line of argument has been reprised in Reis [2009]. His twin-track approach to the stochastic process of aggregate consumption yields significantly higher welfare gains from cycle smoothing in terms of consumption per capita. Such a result applies aptly to emerging economies, where Anderson and van Wincoop [2004] argue that cycle smoothing in Latin American economies can increase consumption per capita by 5 to 10%, an even higher than the estimates computed by Reis [2009] for the United States, from 0.5 to 5%. In addition, Loayza et al. [2007] expand the model by including additional variables, and show that macroeconomic volatility generates adverse effects on consumption per capita, which means that as far as emerging economies go, that trend output is indeed sensitive to the magnitude of the business cycle.

A second methodological argument can be made, one that goes beyond welfare gains. As pointed out in Agénor and Montiel [2015] the literature held a pervasive bias, embodied by the term use of development macroeconomics rather than the macroeconomics of emerging economies. Development macroeconomics implicitly assumes that agents in small emerging economies are endowed with a different rationality that cannot be described with tools usually applied to agents in developed economies. Such an assumption is based on institutional dif-
ferences, and no evidence of fundamentally different economic behaviour is offered. Empirical arguments evolve around issues of data availability and quality, as well as the lack of apparent regularity or patterns in macroeconomic aggregates. In essence, when data is available for emerging economies, its behaviour over time appears to be erratic and random, thus precluding the assumption that these macroeconomic fluctuations can be used as proxies for business cycles. Such a point is made extensively in Agénor et al. [2000]. They provide an exhaustive overview of all limitations regarding data on emerging economies and macroeconomic fluctuations - namely, that data quality, frequency and availability can be of significant hindrance to the analysis of business cycles in developing economies. For instance, their study of a sample made up of twelve developing countries uses industrial production as a proxy for output due to the lack of consistent GDP data. As a result, the literature’s lack of interest in emerging economies’ business cycles is ascribed to limitations on data quality and frequency. These limitations have also been discussed in order to establish a link between data quality and country sample stylised facts. The latter are crucial for policymakers in developing economies because models designed to replicate these stylised facts can help to design stabilisation programmes and cycle-smoothing policies. Data dearth means the literature is constrained in the set of stylised facts it seeks to replicate and explain, which means policy recommendations run the risk of being faulty or incomplete. Nonetheless, Agénor et al. [2000], Agénor and Montiel [2015] and Schmitt-Grohé and Uribe [2017] argue these data issues should not deter research or study of business cycles and macroeconomic fluctuations in emerging economies. They proceed with their country sample to document as exhaustively as possible stylised facts.

Notwithstanding the remarkable degree of homogeneity of some of their stylised facts, emerging economies do not display similar traits on many other aspects. Output fluctuations, measured as the standard deviation of de-trended industrial production, as well as standard deviation in growth rates, are both higher in developing countries than industrial economies. Real wages are strongly pro-cyclical, which fits well with the standard predictions of a Real Business Cycles (RBC) framework. For global trade indicators, industrial output in developed economies has a significant effect on fluctuations in emerging economies. This indicates a positive influence of global trade spillover effects. Similarly, fluctuations in terms of trades are strongly cyclical to output. Nominal variables are however ambiguous, with no strong evidence for nominal wages cyclicity. Furthermore, there is no clear trend as to correlation between monetary aggregates and output across the country sample. Finally, while correlation between domestic credit and output is positive, it varies significantly among countries in the selected sample. Although these results suggest that supply-side shocks rather than demand shocks mostly drive macroeconomic fluctuations in emerging economies, Agénor et al. [2000] offer cautious conclusions. They emphasise the fact that supply shocks may be different from those observed in industrial economies. The importance of terms of trade suggests a mixture of both may be an important component in shaping macroeconomic fluctuations.

A similar research interest has been pursued in Schmitt-Grohé and Uribe [2017]. They too built a large sample of emerging economies, and focused their study of stylised facts on trade and other open economy indicators. Their results overall are line with those described in Agénor et al. [2000], though they focus more on a comparative analysis of the business cycle in emerging economies versus developed ones. Their results confirm that macroeconomic fluctuations in emerging economies are higher in magnitude, but also that consumption is more volatile than output in emerging economies. Furthermore, government expenditure is a-cyclical in those countries, even if another body of literature finds different results. For instance, Talvi and Végh [2005] and Alesina et al. [2008] show that fiscal policy is in fact pro-cyclical. Regardless, the debate on the cyclicality of fiscal policy in emerging economies shows that it does not follow the Keynesian anti-cyclical behaviour, as posited by Barro [1979], which is more commonly observed among developed economies. Similarly, the share of government expenditure in output is countercyclical in the latter than in emerging economies.
elaborate further on business cycle properties by looking at their duration and amplitude, and compare their results with those of developed countries. Their Latin American sample compares well against the OECD benchmark, in the sense that contractions in emerging and developed countries appear to have equal durations of 3 to 4 quarters. The amplitude of these contractions however is significantly larger in emerging economies, with 6.2% of GDP, against 2.2% for the OECD benchmark. The authors thus conclude to the high cost of the downward cycle in emerging economies.

The compilation of stylised facts in Agénor et al. [2000], García-Cicco et al. [2010b], Végh [2013], Agénor and Montiel [2015] and Schmitt-Grohé and Uribe [2017] provides exhaustive evidence to assert that there are business cycles in emerging economies. That is, there are enough regularities and patterns in macroeconomic fluctuations to build a model and seek to replicate them. Furthermore, those authors also show that there are significant costs to the business cycle in the trough phase, which suggests that cycle-smoothing and output stabilisation policies can indeed yield significant gains in terms of consumption, on par with those reported in Anderson and van Wincoop [2004] for instance. Given the fact that so many reported stylised facts for emerging economies fit well with the neo-classical model, it made sense to apply the Real Business Cycle (RBC) framework in order to account for, and replicate macroeconomic fluctuations in emerging economies.

Notwithstanding shock identification issues in the data discussed in Agénor et al. [2000] and more recently discussed by Chari et al. [2009], the past couple of decades have witnessed a rising interest in emerging economies’ business cycles. Papers have evolved from the application of a neo-classical model to account for Argentina’s Lost Decade by Kydland and Zarazaga [2002], to the introduction of a productivity trend shock by Aguiar and Gopinath [2007] as a means to improve the RBC framework’s ability to account for stylised facts in emerging economies. More recently, Comin et al. [2014] expand the RBC framework to mimic the properties of medium Business cycles in developing countries. The literature strove to adapt the RBC research programme to small open economies. This particular class of models is an adequate answer to the point made by Agénor and Montiel [2015] about the misuse of ad hoc macroeconomic specifications, and advocate instead to rely on optimising models. The RBC framework serves a dual purpose: first of all, they are built on the assumption that agent preferences are invariant to policy changes, and second, they establish a robust link between individual maximising behaviour and aggregate variables. Following the Lucas [1972] critique, a model specification that fails to take into account agent response to policy changes in their own set of policy rules is inadequate and lacks rigorous micro-foundations. Similarly, these models can define forward-looking agents in a dynamic setting that can account for a range of issues and stylised facts observed in small open emerging economies. In that sense, RBC models are an ideal candidate in our attempt to describe and replicate macroeconomic fluctuations in emerging economies.

Fiscal policy is prominent among the many domestic factors that can exacerbate the cycle and its adverse effects on aggregate welfare. Besides the Lucas [1972] critique, taxes generate distortion effects on agents’ optimality conditions and decision-making schedule. Chari et al. [1994] look at optimal fiscal policy in a business cycle model, and assume that all government expenditure are exogenous and funded by taxes levied on consumption, labour and capital. The same goes for Schmitt-Grohé and Uribe [2004, 2005] who offer a model where government expenditure is an exogenous demand component for a composite public good. They assume the government seeks to minimise the cost of producing units of public goods. Further more, while public expenditure is considered to be a component of aggregate demand, it does not feature in households’ utility function. Similarly, Rotemberg and Woodford [1999] in their New Keynesian model, the public sector is represented as an exogenous variation of government purchases. The model formulated in Smets and Wouters [2003, 2007a] which seeks to describe the Eurozone area also treats government expenditure as a source of exogenous shocks. Using an
extended New Keynesian framework, they argue government purchases contribute to output via aggregate demand, but do not model its internal dynamics beyond those of a source of exogenous shocks. As pointed out in Agénor et al. [2000] there are many emerging countries where public expenditure is pro-cyclical, which means government purchases have to be treated other than just a residual exogenous demand. Many of those economies have a larger government sector than observed otherwise in developed nations. There are also issues of governance to contend with, which need to be accounted for as well. In keeping with the research programme set out in Agénor and Montiel [2015] we seek to model government policies in a micro-founded setting. Agénor [2009] argues that government expenditure in investment can boost growth, and generate positive externalities. Increased access to infrastructure participates in expanding markets and private investment, thus benefiting the whole economy. This argument can be turned around: government expenditure can also generate negative externalities, and exacerbate the cycle instead of smoothing it. Hakura [2009] estimates factor contribution in output growth drops in developing and industrial economies. He finds that there are substantial gains in output volatility reduction for emerging economies in moving away from discretionary fiscal policy. Clearly, the government sector has to be modelled as a fully-fledged agent in account for macroeconomic fluctuations in small open emerging economies.

Though the literature is quite comprehensive in dealing with fiscal policy, there is no clear consensus on how to model government economic behaviour. This lack of clarity stems from the potential role of political institutions in shaping government policy. The orthodox view discounts these elements, for instance in Gavin and Perotti [1997]. They enumerate stylised facts pertaining to fiscal policy in Latin American economies, and offer interpretations as to why fiscal policy is pro-cyclical in those economies. Their discussion does not touch upon institutional issues however, which limits the scope of their conclusions. Barro [1979] links the dynamics of debt accumulation and expectations of fiscal pressure to countercyclical government expenditure. He concludes that only unanticipated changes that affect the government’s budget constraints should compel it to accumulated debt. Following Barro [1979], the literature assumes that the path of government spending is taken as exogenous, in which case full tax smoothing prevails. Strawczynski and Zeira [2013] observe that business cycles in emerging economies are sufficiently persistent that they affect long-run fundamentals. They posit that pro-cyclical fiscal policy is a potential channel, as it exacerbates the cycle. Their model thus combine fiscal pro-cyclicality with the business cycle and posits instead that tax rates are taken as given, while government expenditure is endogenous. The alternative view is advocated in Talvi and Végh [2005]. They study the pro-cyclical fiscal policies in developing economies, and compare them against those anti or a-cyclical policies prevalent in G7 countries. They argue the differences between fiscal policies in developing and developed economies reside in a much more variable tax base in the former. In their view, excessive volatility does not stem from unstable policies but rather from the limitations that define fiscal revenues. Although they assume an endogenous component to government purchases, they still rely on a Ramsey allocation to do so. Alesina et al. [2008] build on Talvi and Végh [2005] by focusing on factors behind political distortions. They are much more explicit in identifying political institutions as a primary cause of inefficient government expenditure, as their model features a corrupt government that can appropriate tax revenues for unproductive public purchases. This agency problem fits well with the Agénor and Montiel [2015] standard of micro-founded models for emerging economies. Dixit et al. [1997] use the Principal-Agent model in a multilateral contract to describe government policies. They propose a model of public finances with multiple principals, and the public sector acting as the agent. Their model design taxes and subsidies in a Nash equilibrium that may not coincide with the socially desirable outcome. They argue that in standard agency theory models, the government’s social function weights utilities of favoured groups, whereas less favoured groups are allocated the minimum level of utility. The existence of multiple principals creates an issue whether a government policy outcome may be efficient to them individually. These issues are
also discussed in Acemoglu and Robinson [2009]. In terms of domestic factors, it is clear that
the literature considers institutional failure to be a key source of inefficiencies and excessive
macroeconomic fluctuations.

In order to capture the political economy of taxation in emerging economies, we formulate a
model designed to build a Laffer [2004] curve using the framework developed by Trabandt and
Uhlig [2011, 2012]. We focus in particular on the importance of underground economic activities
relative to output, as well as the collection cost tax authorities in these economies face. The
sizeable share of underground economic activities in aggregate production is such that it cannot
be entirely ascribed to an unbearable tax burden. After all, the argument laid out by Feige and
McGee [1983] and Laffer [2004] is that tax rates set beyond their peak values prompt economic
agents to leave the market place. Regardless of the tax rate, underground economic activities
continue to operate undeclared and/or untaxed. The explanations for this are multifarious: the
tax base may be elusive, such as the case for agricultural output, as argued by Khan [2001]. It
could also be due to the fact that the tax base is too variable for governments to rely on steady
flows of tax revenues, an argument put forward in Talvi and Végh [2003].

We argue therefore that the best way to gauge macroeconomic fluctuations in small open
emerging economies is to explicitly incorporate market and institutional imperfections. The
limitations of the RBC framework in that respect show that the New Keynesian models are
suitable for that purpose. Policy and market failure need to be accounted for explicitly in our
models for two main reasons. First, they improve the erstwhile RBC model framework’s ability
to replicate stylised facts and expand the range of properties they can mimic. Second, real and
nominal rigidities they generate can be estimated using the business cycle accounting developed
in Chari et al. [2007]. Their method provides an estimation of wedges in labour, investment and
government purchases, and are then fed back into the benchmark model. The purpose of such a
method is then to provide an assessment of how much these wedges contribute to fluctuations.
The same method can also be applied to estimate institutional wedges, and thus measure the cost
of institutional imperfections in emerging economies. Business cycle accounting in a universe
of diverse sources of exogenous shocks can improve stabilisation policies’ intended results, and
thus payoff with welfare gains for economic agents. Chari et al. [2007] demonstrate that models
with sticky prices and monetary shocks can be approximated with a standard growth model
with labour and investment wedges. We use this analogy and extend it to government policy as
well, and argue that institutional imperfections act as a wedge, and as a result their cost can be
estimated thanks to the general model.

The RBC-based literature focuses in particular on two well-documented stylised facts: house-
hold expenditure fluctuates more than output, and trade balance to output ratio is counter-
cyclical. Starting with Mendoza [1991] who addresses various topics in international macroe-
conomics using an extended RBC model framework to accommodate stylised facts observed in
Canada, a small open economy. The model is derived from standard RBC specification as in
Backus et al. [1992] and inaugurates a literature that sought to match particular stylised facts
specific to small open economies. Mendoza [1991] concludes that most countries have well-defined
regularities (stylised facts) in domestic and external indicators, and the extended RBC model
can reasonably account for most stylised facts observed in a small open economy. Using Agenor
et al. [2000] initial argument that sudden stops and crises cast doubt as to the existence of busi-
ess cycles in emerging economies, Kydland and Zarazaga [2002] contend that a neo-classical
growth model can replicate the Lost Decade in Argentina. This event refers to a severe decline in
real GDP per capita during the 1980s, a case in point of crises prevalent in emerging economies
for many years. Kydland and Zarazaga [2002] argue that economic depressions should not be
construed as a rejection by individual agents of expectations formation or standard economic
behaviour. Since then, the literature has refined its understanding of business cycles in emerging
economies, where Schmitt-Grohé and Uribe [2004, 2005] are interested on the long-run effects
of temporary shocks on a small economy. They argue that the RBC framework can adequately
integrate unit root shocks without substantial alterations. Their paper dealt with a myriad of model variations, whose results are similar enough to conclude model extensions are cosmetic. They further argue that computational aspects are sufficient enough to deal with trend shocks, and essentially render all relevant model variables stationary.

Aguiar and Gopinath [2007] develop this argument further, and introduce shocks to trend productivity explicitly in order to replicate two salient stylised facts: excessive household expenditure fluctuations relative to output and counter-cyclical trade balance-to-output ratio. They argue that a neo-classical model can subsume all exogenous effects arising from potential policy and market failures into an aggregate productivity shock with a trend component. They contend that RBC models systematically fail to replicate a stylised fact common to many emerging economies, namely that household expenditure is more volatile than output. The authors argue that in a forward-looking environment, an exogenous trend shock generates a permanent increase in productivity. Households therefore take advantage immediately by increasing consumption at a level above that of output response to productivity shocks. Thus private consumption becomes more volatile than output and the model matches those stylised facts reported in Schmitt-Grohe and Uribe [2017]. The same behaviour means that households need to import goods to make up for the shortfall in domestic production, hence counter cyclicality observed in trade balance. In essence however, the RBC framework is retained as per Schmitt-Grohe and Uribe [2004, 2005]. It appears that a new consensus in RBC-led literature formed around the Aguiar-Gopinath model. Namely, small emerging economies are subjected to a variety of exogenous shocks that can be consolidated into a productivity shock with a unit root. Shocks to trend productivity generate enough volatility to account for stylised facts the standard RBC framework fails to replicate, namely consumption excess volatility relative to output.

Nevertheless, such an argument is disputed in García-Cicco et al. [2010b]. They look at business cycles in a large set of Latin American economies, and seek to replicate their stylised facts using variations of the extended RBC framework. While they do not dispute the need to incorporate shocks to trend productivity in the RBC model, they do find that such a stylised fact can only be obtained by shutting down every other source of exogenous shock save for trend productivity. Such an assumption runs against evidence of stationary shocks as the main driver behind macroeconomic fluctuations, per Mendoza [1991]. Furthermore, they find the RBC model performs poorly in replicating trade balance to output ratio auto-correlation, which means the RBC framework fails on stylised facts pertaining to trade balance as well. García-Cicco et al. [2010b] offer instead a mixture of exogenous shocks, such as demand-driven or country-premium as possible remedy for RBC models to adequately replicate observed moments in emerging economies’ business cycles. Furthermore, the adapted RBC framework to emerging economies runs afoul the objective stated earlier, of formulating a general equilibrium model that provides policy analysis. Models developed from Mendoza [1991] to García-Cicco et al. [2010b] are all built on some variation of the Walrasian setting. This means that fluctuations in the business cycle are the result of agents’ optimal responses to exogenous, stationary shocks. The RBC model leaves little room for macroeconomic policy, which negates the substantial welfare gains expected from cycle-smoothing policies, per Anderson and van Wincoop [2004]. In addition, the RBC framework performs poorly when it comes to monetary policy, and more generally nominal shocks. Hairault and Portier [1995] seek to introduce money in an RBC model via a cash-in-advance constraint. They reach similar results to those in Cooley and Hansen [1989] and conclude that nominal shocks are not adequately captured, and the modified model is unable to replicate correctly nominal stylised facts. Failure on part of the RBC model framework to account for money and inflation in an RBC model, as well as replication of some stylised facts compel us to look for alternative specifications. It is therefore possible to assert that the assumption made by Aguiar and Gopinath [2007] about consolidating various exogenous shocks into a real trend component does not stand, and should be replaced.
Among its many limitations, the extended RBC framework effectively shut down all other sources of exogenous shocks, contrary to all available evidence. It has also been unable to adequately replicate autocorrelation features in trade balance to output ratio. In addition, because it focuses on real variables, the RBC model fails to account for stylised facts on nominal variables and their dynamics with output and other real variables. Finally, the assumption embedded in those models that posit agents in emerging economies respond optimally to exogenous shocks is neither methodologically sound, nor empirically validated. For all the shortcomings reported earlier, the RBC framework was tractable enough for the literature. It has proved to be useful as a benchmark for replication of stylised facts in emerging economies. Its subsequent extensions improved on its ability to account for a larger set of moments common to those economies. It becomes necessary therefore to find a new generation of models that can build on what the RBC models have been able to achieve. The proposed generation of alternative models should be able to mimic those stylised facts the RBC framework got right, improve on those it does not adequately replicate, and finally explain those properties the RBC model misses out completely.

In an open economy setting, the literature has changed its focus over the years. The standard Mundell-Fleming framework (Mundell et al. [2004] and Calvo and Mundell [2001] for instance) has given way to a more micro-founded setting due to its limitations and lack of theoretical consistency, as reported in Frenkel and Razin [1987]. The broad lines of this research programme have been set forth by Backus et al. [1992]. Their study of international business cycles focus on the effects of spillover effects of productivity shocks from foreign to the domestic economy. Their model extends the standard RBC framework to an open economy. Their results improve on the ability of the RBC framework to account for stylised facts by incorporating additional trade indicators. They also offer some measure of explanation to well-known puzzles of international macroeconomics. Most importantly, the model put forward by Backus et al. [1992] concludes to the need to incorporate trading cost in order to improve its ability to mimic fluctuations in the benchmark economy. Obstfeld and Rogoff [2000] In their study of well-known puzzles of international economics offer a similarly compelling argument for friction and trading costs. They conclude therefore to the need to incorporate trade costs in the goods market. Such a hypothesis was backed up in Mendoza [1991] as a conclusion for the RBC framework to improve its ability to replicate stylised facts and include trade frictions in a small open economy. Obstfeld and Rogoff [1993, 2000] argue that an imperfect competition setting with sticky prices needs to explicitly incorporate trade costs. The importance of trade costs stems from the persistence of the so-called home bias - which a fully integrated economy in global trade should not display. Trade costs may also account for price stickiness and the subsequent volatility in exchange rate standard models are unable to replicate. Obstfeld and Rogoff [2000] give a broad definition to those trade frictions, including tariff and non-tariff barriers. More specific measures of the so-called iceberg cost is put forward by Anderson and van Wincoop [2004], and Irarrazabal et al. [2015]. This allows us to link market imperfections with policy designs. Obstfeld and Rogoff [1995] provide a similar argument with a dynamic model that incorporates government spending in a simple setting where it is purely dissipative. At the firm level, frictions in the production schedule can also impede trade, and distort relative prices between domestic and imported goods. In particular, Ghironi and Melitz [2005] model firm-level frictions in order to account for the discrepancies between trade theory and empirical data. These firms face sunk and/or fixed costs and heterogenous productivity shocks, both of which alter substantially the composition of household preferences and their consumption index.

Transitioning away from the RBC framework should nonetheless not be construed as a repudiation of the findings in the literature mentioned above. What is true for developed economies holds equally well for emerging ones. Bénassy [2002] offers a brief historical compendium of modern macroeconomics to show that the relaxation of Walrasian assumptions does not reject

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Lane [2001] offers a comprehensive literature survey on the subject.
en bloc RBC teachings. A more comprehensive survey of the literature in \cite{Vroey2016} argues that second-generation New Keynesian models have been developed with the purpose of fitting the RBC-based models to the data. In essence, the New Keynesian model grafted nominal price sluggishness and monopolistic competition onto an RBC framework, and thus contends that the New Keynesian synthesis is an outgrowth of the former. The reason offered in \cite{Vroey2016} conforms with the stated aim of this dissertation as well: Given the fact that RBC models fail to capture stylised facts related to nominal variables, we seek alternative results in a general equilibrium model framework that allows for price rigidity. In order to achieve it, some substantial changes are introduced in the Walrasian RBC framework. In order to introduce price sluggishness, producers need to be endowed with some market power. Because either monopoly or oligopoly specifications run against empirical evidence, the literature introduces monopolistic competition, and price rigidity ensues. In the scope of our research, New Keynesian models are preferred because they can go beyond the limitations displayed by RBC models in account for emerging economies’ stylised facts. The New Keynesian models abide by the Dynamic Stochastic General Equilibrium standards set forth in \cite{KydlandPrescott1998} and provide strong micro-foundations called for in \cite{AgenorMontiel2015}. Price stickiness and monopolistic competition go hand in hand, allowing for the assumption that agents are price-takers to be dropped. As pointed out in \cite{Watson2016}, openness to trade exercises ambiguous effects on price stickiness. On the one hand, the competitive effect reduces price sluggishness, because domestic firms have to track their marginal costs more frequently to face competition from imported goods. On the other hand however, as mentioned in \cite{Kimball1995}, intermediate goods are strategic substitutes. Given the household’s preference for diversity in their consumption index, there are strategic interaction effects that divorce domestic firms’ pricing schedule from their average marginal costs.

A staple of modern macroeconomic literature is to use the \cite{DixitStiglitz1977} consumption index as a definition of monopolistic competition. They model consumers preferences with a basket of consumption goods defined by imperfect elasticity of substitution. \cite{BlanchardKiyotaki1987} elaborate in turns on the Dixit-Stiglitz index in their study of shifts in aggregate demand and their impact on the economy. Under monopolistic competition, output is below its competitive level. In a setting where there are strategic complementarities between intermediate goods, no firm has incentive to decrease its price, and increase its output. In this case, money balance can have a real effect on output, since it can induce price-setters decrease their prices simultaneously, thus increasing aggregate supply. Non-neutral money has therefore been achieved thanks to monopolistic competition on the one hand. In a general equilibrium setting, sluggish price changes can be introduced either as real adjustment cost, or a random process. The former is modelled after \cite{Rotemberg1982}, where firms face costs in changing their prices from one period to another. The second is the so-called \cite{Calvo1983} indexation mechanism, where price changes are random, and partial price indexation yields similar results. Furthermore, New Keynesian models allow for the explicit incorporation of additional sources of exogenous shocks, as described in \cite{Ireland2001, Ireland2004}. A diverse set of exogenous shocks allows us to study more closely factors driving macroeconomic fluctuations in emerging economies. Variance decomposition for macroeconomic aggregates of interest can be useful in terms of policy recommendation for instance. Nevertheless, there are limits to what the model can allow for in terms of exogenous shocks, as underlined by \cite{Chari2009}. In short, the New Keynesian models can achieve what the previous model generation has been unable to deliver, namely to account for real as well as nominal stylised facts. For instance, our research needs to account for stylised facts involving inflation. This means price rigidity needs to be incorporated in our proposed models, which involves monopolistic competition, hence the New Keynesian framework.

The issues discussed above should be considered in the context of a small, open emerging economies. This means that all market imperfections, such as monopolistic competition and price sluggishness, are also affected by trade interactions. We argue in this dissertation that
the literature does not address the issue of trade openness head-on. In particular, we focus on the micro-foundations of the New Keynesian Phillips Curve (NKPC) in an open economy environment. A forward-looking NKPC equation links inflation to the output gap, which is defined throughout the New Keynesian Synthesis literature as deviations of the average marginal cost (See Clarida et al. [1999], Ireland [2001], Bénassy [2002] and Woodford [2003] for instance). It sets inflation dynamics as a function of expected future changes in the output gap. In a closed economy setting, price-setters are sensitive to only a few factors, all encompassed in the typical New Keynesian model presented in [Galí 2008]. In an open economy setting however, goods produced by domestic firms interact with imported ones. Following Watson [2016] the increased strategic interaction between domestic and foreign goods has an ambiguous effect on inflation. On the one hand, increase strategic interactions detach price-setting from changes in domestic firms’ marginal costs, thus increasing price sluggishness. On the other hand, increased competition from imported goods compels domestic firms to be more responsive in their price setting to changes in their marginal costs. The ambiguity implied in these seemingly contradictory effects works to our advantage, since it can account for differences in collected stylised facts for emerging economies.

The New Phillips Curve in an open economy reprises the New Keynesian Synthesis model and incorporates trade variables, as described in Galí and Monacelli [2005]. The Phillips equation slope becomes therefore sensitive to openness to trade, or more precisely, to the domestic bias embedded in consumer preferences. In our model, the incorporation of iceberg costs and relatively high elasticity of substitution between domestic and imported goods is such that price stickiness in emerging economies may be increased if iceberg costs are reduced. In light of these findings, this dissertation argues the following: comprehensive examination of the data on emerging economies shows that there are regularities in macroeconomic fluctuations. Economic agents in emerging economies behave similarly to those in developed ones, and can therefore be described and analysed with the standard tools of modern macroeconomics. The differences are due to the institutional setting, as well as stronger market imperfections that are more common in emerging economies than developed ones. Our research argues that these models can indeed mimic fluctuations in small open emerging economies. The proposed models draw on the RBC literature as well as the New Keynesian synthesis.

1.2 Outline

This PhD dissertation is structured as follows: in the first chapter, we focus on the accumulation and description of data related to macroeconomic fluctuations in emerging economies. We review the literature and its results, particularly those from Agénor et al. [2000], Calderon and Fuentes [2010] as well as Schmitt-Grohé and Uribe [2017]. Stylised facts are critical to the undertaking of this dissertation for two main reasons: first, they document macroeconomic fluctuations beyond the cursory look at seemingly volatile and random changes in macroeconomic aggregates. Second, they set a benchmark of properties the models proposed in the following chapter should replicate. This preliminary step is thus necessary to undertake, given the issues related to data availability and reliability in these economies. We recapitulate properties of macroeconomic fluctuations in emerging economies and classify them in three broad categories: those stylised facts they have in common with developed countries, those specific to developing ones, and those stylised facts that elicit no clear consensus among emerging economies themselves. This compendium of stylised facts is key to policymakers on two counts: it offers an initial assessment of business cycle magnitude and properties of the business cycle in emerging economies. Then, the policy-markers can formulate a model able to replicate those stylised facts, with expected significant welfare gains yielded thanks to cycle smoothing policies. Loayza et al. [2007] have argued that expected welfare gains from dampening fluctuations in the business cycle can be substantial. They argue that developing countries are subject to larger exogenous shocks, the
effects of which may be exacerbated by their imperfect market structures and institutions. Policymakers in emerging economies can thus expect to generate substantial welfare gains - compared to developed countries- by putting in place cycle-smoothing policies.

In dealing with stylised facts, the first chapter looks in particular to the role of external factors in shaping macroeconomic fluctuations. After an exhaustive description of stylised facts for a large sample of developed and emerging economies, we find that, in contrast to findings in the literature, such as Kose et al. [2003], global and regional factors affect all economies regardless of income level. We also show that country-specific factors have a marginally higher impact on emerging than developing economies. These results are in line with stylised facts compiled in Agénor et al. [2000]. They also suggest there are limits to welfare gains policymakers in emerging economies can expect to achieve thanks to smoothing the business cycle, using only domestic instruments. Given the importance of foreign trade, this component has to be considered as a prime candidate for transmission channel of global and regional exogenous shocks and spillover effects.

The second chapter studies domestic sources of distortions and inefficiencies. In particular, we are interested in the effects of taxation in emerging economies. The large underground economic sector and high tax collection costs that are common to these countries hamper tax authorities’ ability to extract taxes at levels similar to those of developed ones, where the tax system is more efficient. We use the Laffer curve as described and summarised by Laffer [2004] to investigate why the tax burden is relatively low in emerging economies. We first use a baseline model built following Trabandt and Uhlig [2011, 2012]. The micro-foundations we bring to the Laffer curve allow us to incorporate the distortionary effects of taxes in their respective tax bases. The baseline model describes a canonical RBC framework where the household maximizes their utility subject to resources and technology constraints. The model is augmented with taxes on capital, labour and consumption, whose distortionary effects are reported in the household’s optimality conditions. The Laffer curves for the three tax bases are then depicted using the calibrated values for a large sample set of developed and emerging economies. The baseline model is then enriched with a component that captures the effects of an underground economy. Using measurements from Frey and Schneider [2000], Schneider et al. [2010] and Schneider and Bühn [2013], we show that a large underground economic sector relative to output generates ambiguous results on the tax base. On the one hand, untaxed/undeclared economic activities have a larger potential tax base, because they do not experience distortions brought about by taxation. On the other hand, because tax authorities can assess only the declared/legitimate share of the tax base, their revenues are comparatively low. As a result, even though the Laffer peak rate shifts right and increases in value. As a result, the Laffer curve itself flattens, and the associated peak revenues decline. The baseline model is further enriched with tax collection costs, defined in a manner similar to that of Yesin [2004]. Changes in the tax rate are increased in order to make up for costs associated with collecting tax revenues. This means that the distortion effects brought about by taxation are exacerbated, since marginal changes in the tax rate are larger. As a result, the Laffer curve shifts to the left and is steeper to the right. This change is associated with a lower peak tax rate, and steeper declines in marginal tax revenues when the rate is set beyond its peak value.

The third chapter expands on the open economy formulations of the New Keynesian Phillips Curve put forward in Gali and Monacelli [2005] and Razin and Yuen [2002]. The Phillips equation writes inflation as a function of expected and discounted fluctuations of the average marginal cost around its steady-state value. Price stickiness is measured as the sensitiveness of inflation to these changes, and is significantly affected when the model is formulated in an open economy environment. We elaborate in this chapter on the baseline of Gali and Monacelli [2005]. We argue that trade costs, and a high enough elasticity of substitution effect between domestic and foreign goods will achieve a larger impact on price stickiness. Furthermore, openness to trade, in the
form of low iceberg costs may raise price stickiness, even as it contributes to lowering inflation, per [Romer 1993]. This is due to the fact that the absence of competition from imported goods allows domestic firms to track more closely their marginal costs, thus rendering domestic prices less sluggish. A low elasticity of substitution between domestic and imported goods increases price stickiness, as it exacerbates the strategic complementarity effect between the two consumption goods. We conclude that while emerging economies exhibit lower levels of price sluggishness in comparison with developed countries, further integration in global trade through lower iceberg and trade costs may mitigate that price flexibility. The distortion effects are such that we expect trade indicators to be sluggish in their adjustments, too. In particular, it can be argued that trade balance-to-output ratio will be slow to adjust to exogenous shocks, which accounts for the salient stylised fact of fairly persistent autocorrelation in the trade balance ratio.
Bibliography


Chapter 2

Are all cycles alike? An empirical investigation of regional and global factors in developed and emerging economies.
Are all cycles alike? An empirical investigation of regional and global factors in developed and emerging economies.

Abstract

The conventional wisdom in the literature considers that business cycles are more volatile in emerging economies than developed ones. It ascribes this excess in macroeconomic fluctuations to domestic and idiosyncratic factors. As a result, policy recommendations predict substantial welfare gains from cycle-smoothing domestic policies. We take the opposite view in this paper/chapter, and argue that although business cycles are more volatile, cross-country contribution of domestic factors to output volatility does not vary significantly. Using income- and region-based group categories, we show that global factors account for 37% to 48% of the de-trended output variance in emerging economies, substantially more than the 5% to 15% range reported in the literature. By comparison, approximately half of output variance in developed economies is accounted for by global factors. We conclude that global and regional factors account for the bulk of output fluctuations in all economies, and that domestic factors are marginally more important in emerging economies than in developed ones. Therefore, cycle-smoothing domestic policies in emerging economies may not be as effective as the literature suggests.

JEL Codes: C14, F20, F44.

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A life on the ocean wave! A home on the rolling deep! Where the scattered waters rave, and the winds their revels keep! Like an eagle caged I pine, on this dull unchanging shore.

Epes Sargent
2.1 Introduction

Lucas’ [1977] assertion that one is led by the facts to conclude that [...] all business cycles are alike may be construed as too strong a statement as far as emerging economies are concerned. For one, it is only recently that the business-cycle framework has been recognised as a concept fit to describe short-run macroeconomic fluctuations in emerging economies. In addition, an abundant literature has documented the differences in output fluctuations between developed and emerging economies. Furthermore, standard measures for macroeconomic fluctuations in the latter suggest that these experience significantly higher levels of output volatility. As a result, it is reasonable to be sceptical of Lucas’ assertion.

Measurements of business cycles provide ample evidence that output in emerging economies experiences higher magnitude fluctuations compared to that in developed countries due to endemic sudden stop episodes and recurrent financial crises. Exogenous shocks, whether foreign or domestic, shape macroeconomic fluctuations in emerging and developed economies alike, but factor contribution varies across category groups. The literature argues that domestic factors account for a substantially larger share of output volatility in emerging economies, than in developed ones. We argue in this paper that such a claim is highly debatable. Indeed, we find that while domestic factors contribute more to output fluctuations in emerging economies than they do in developed ones, they are much less important than otherwise argued in the related literature. More specifically, we find that contribution of global factors to macroeconomic fluctuations in emerging economies does not significantly differ from that of developed ones.

We build a sample set of 100 countries of various regions and income groups, and study their respective macroeconomic fluctuations, measured as the variance of de-trended output. We are interested in particular in the respective contributions of global, regional and country-specific factors. The main focus of our paper is on emerging economies and on how global and regional factors shape their macroeconomic fluctuations. Given the comparatively richer literature on macroeconomic fluctuations in developed countries, as well as the wealth of evidence regarding their own business cycles, we choose to incorporate these in our analysis as well. The rationale for such a choice can be explained as follows: as mentioned before, the business cycle concept as applied to emerging economies is a relatively new item in the literature, both due to theoretical and data-related issues. Those stylised facts we derive for emerging economies need to be compared against an established body of literature, but this is comparatively lacking in terms of macroeconomic fluctuations in these economies. Consequently, this paper will focus on those stylised facts common or specific to emerging economies, and use those observed in developed countries - and in related literature as a benchmark.

The contributions of this paper/chapter reside in the departures from the consensus in the literature, both in our methodology and the results it produces. First, literature uses standard deviation for real GDP per capita growth rates as a measure for macroeconomic fluctuations. We argue that growth does not capture adequately macroeconomic fluctuations, and in fact may overstate them for emerging economies. Instead, we estimate business-cycle moments with de-trended real output per capita, as this latter proves to be more appropriate for capturing macroeconomic fluctuations in emerging economies. To build an adequate proxy for macroeconomic fluctuations, we rely on standard filtering techniques, in our case the rolling 10-year standard deviation for de-trended output. Second, this paper relies on nonparametric regression to estimate the effects of global and regional factors, while country-specific factors are treated as a residual. In fact, a more recent body of literature tends to buttress our own results, namely, by finding that global factors contribute more significantly to business cycle fluctuations in emerging economies. Dynamic factor models in particular are a regular staple for estimating unobserved common factors, and usually are defined within a parameter-rich environment, supplemented by assumptions of data-generating processes that may contradict the underlying characteristics of the data itself. Kose et al. [2003] describe their methodology at length; it focuses on
the properties of unobserved factors that govern co-movements in the data, and are defined using autoregressive representations. Most importantly, these restrictions do not conform with the basic properties of a business cycle: as mentioned in Agénor et al. [2000] fluctuations in emerging economies are quite similar to those in developed countries, among others, in their significant persistence. Nonparametric estimation, by contrast, does not impose any particular form of data-generating process, and are therefore more flexible in accounting for global and regional factors. The tests developed in Racine [1997] confirm the robustness of our results. More precisely, we carry out nonparametric estimations in two steps: in a first-stage, global and regional factors are extracted from the country sample, and in a second-stage, their respective contributions to output fluctuations are estimated via nonparametric regression.

In addition, nonparametric estimation results are more sensitive to individual countries’ changes in output fluctuations - crisis episodes common or specific to regions are more likely to be captured in a structure-free estimation than in a parametric setting. For instance, the effects of the 1997-1998 crisis in South Asia are captured more accurately in our estimation results, which include thus a more potent regional factor than other parametric models may suggest. The results are checked for robustness using standard nonparametric tests, which are found to be satisfactory, and to yield more robust estimates than those encountered in the literature. Fourth, the results laid out in this paper conclude that country-specific factors in high income economies account for approximately 7.5% of observed fluctuations, while in emerging economies, they account for 18% on average. Furthermore, global factors account for about half of output fluctuations in wealthy economies, against a little under 40% in emerging economies. These results are significantly different from those in the literature, which for emerging economies has country-specific factor contributions to output fluctuations at approximately 70%, and global factors at under 10%, which suggests large discrepancies with estimates.

Overall, our contributions to the literature can be summarised as the use of alternative estimation instruments, and new estimations of the estimated respective contributions of global and regional factors to macroeconomic fluctuations in emerging economies, which we find to be quite close to those observed for developed ones.

This paper is delineated as follows: the first section reviews the main results in the related literature, and compares them against those laid out in our paper. We stress the main differences between other methods and our own econometric approach. The second section presents descriptive statistics regarding our country group sample for an array of macroeconomic indicators. A series of statistical tests are conducted to document as exhaustively as possible the stylised facts, by using the OECD country group as a benchmark for the emerging economies and the geographical country groups they respectively belong to. The third section introduces the nonparametric estimation techniques used to extract global and regional factors and discusses their behaviour over time. This section also estimates their respective contributions to output fluctuations, and compares these results with those encountered in the literature. We conclude in the fourth section that a cycle-smoothing policy in emerging economies can achieve the desired results if the sources of fluctuations are correctly identified, which was the underlying purpose of this paper. This section focuses on the importance of external factors because they shape fluctuations in emerging economies. Policymakers in emerging economies can expect to devise cycle-smoothing policies, given the significant gains to be expected from them. However, given the importance of global factors and their contribution to the business cycle, policymakers in emerging economies face limitations in how much they can yield in terms of welfare gains if they intend to smooth the business cycle by affecting domestic factors.
2.2 Literature review

The purpose of this section is two-fold: First, it establishes the challenges met in addressing macroeconomic fluctuations in emerging economies. The shortage of quality data for these economies has restricted the literature’s interest in describing their macroeconomic fluctuations, and so business cycles in emerging economies are frequently compared against those of developed ones. Second, we lay out the methodologies and ensuing results from a literature that focuses on underlying factors and their respective contributions to macroeconomic fluctuations, in developed and emerging economies alike.

Agénor et al. [2000] provide an exhaustive overview of all limitations regarding data on emerging economies and macroeconomic fluctuations. Namely, that data quality, frequency and availability can be of significant hindrance to the analysis of business cycles in developing economies, and doubts are even present regarding the existence of regularity in observed macroeconomic fluctuations. In the authors’ view, the relative lack of interest from the literature in business-cycle analysis in emerging and developing countries is due to such limitations. Agénor et al. [2000] also discuss the literature’s initial reluctance to term macroeconomic fluctuations in emerging economies as business cycles. The latter assume the existence of patterns and some regularity that was not observed at first hand in the macroeconomic aggregates of emerging economies. The literature restricted itself to study some of those economies for whom data was available and of acceptable quality. Consequently, the lack of good quality data has influenced the choice of groups of countries used to establish a number of key stylised facts for all emerging and developing countries. These choices have influenced heavily economic policy recommendations for these countries, concerning mainly stabilisation programs and cycle-smoothing policies. Despite these data problems, a research program on macroeconomic fluctuations in emerging and developing countries has been developed nonetheless. Agénor et al. [2000] consider that these countries are relatively homogeneous in terms of business-cycle features. Overall, the authors find that there is strong evidence of spillover effects from industrial production in developed economies to emerging ones. There is also good evidence supply shocks appear to have a dominant influence over macroeconomic fluctuations in emerging economies, which points to striking similarities with developed countries. These results are supplemented in Schmitt-Grohé and Uribe [2017] carry out a similar analysis, as they catalogue stylised facts for emerging economies. They focus in particular on excess output volatility with respect to developed economies, as well as contemporaneous correlations between macroeconomic aggregates and their respective autocorrelation. All in all, Schmitt-Grohé & Uribe do not dispute the conclusions about the possibility of treating output fluctuations in emerging economies as business cycles. In view of these elements, we follow in this paper the groundwork laid out by Agénor et al. [2000] as well as Schmitt-Grohé and Uribe [2017] by looking at a large sample of emerging economies, and documenting as exhaustively as possible their stylised facts, common or specific to sub-groups.

In the research program they advocate, Agénor et al. [2000] have argued that macroeconomic fluctuations in emerging and developing economies have exhibited enough regularity to extract some stylised facts. Macroeconomic fluctuations in those economies thus qualify as an adequate approximation of their business cycles. In addition, the compendium of stylised facts offered by the authors compares systematically against those common to developed economies in order to underline those common features they argue are proof that macroeconomic fluctuations in emerging economies are business cycles, too. Our paper takes its cue from these conclusions in order to investigate domestic and foreign factors’ contribution to the business cycle. Estimated results for output variance decomposition are key to better explain those business cycle stylised facts observed in emerging economies. The literature most closely related to our paper refers to the sources of shocks that drive these macroeconomic fluctuations. Kose et al. [2003] argue that business cycles in developed and emerging economies are predominantly driven by domestic and
country-specific factors. They use a Bayesian dynamic factor model in order to extract common component in three macroeconomic aggregates, namely output, consumption and investment. They focus on G-7 countries, and extract global, regional, country-specific and idiosyncratic factors and their respective contributions to macroeconomic aggregate variance.

Using a sample set of 60 countries, Kose et al. [2003] find that macroeconomic fluctuations are accounted for in a significant way by a common global factor, suggesting the presence of a world business cycle, a finding that we share in our own methodology. However, they also find significant differences in factor contribution to output variance decomposition between developed and developing economies. Their G7 country sample shows that between 33% and 38% of output variance can be accounted for by domestic (or country-specific) factors. Country-specific factor contribution to output variance in emerging economies increases to a figure ranging between 67% and 72%. Our figures stand at odds with these results, since the common, global factor computed by nonparametric regression in our model puts its contribution to output variance at roughly the same for emerging and developed economies. Findings in Kose et al. [2003] are based on demeaned output growth (as well as consumption and investment growth rates) and these results are predicated on the fact that growth is not serially correlated. We argue that there are pitfalls to these proxies on several counts: first, as mentioned above, output growth tends to overstate variance for emerging economies, and thus discount the impact of the global factor on output growth variance in those economies. Second, the assumption that growth is not serially correlated does not stand scrutiny, in view of the results laid out in Agénor et al. [2000]. This assumption further contradicts the literature’s use of output growth, rather than de-trended output, as a proxy for the business cycle. Indeed, Agénor et al. [2000] show that macroeconomic fluctuations in emerging economies are considerably persistent.

Hakura [2009] applies a similar technique to estimate global, regional and country-specific factors. Using a rolling 10-year standard deviation for real output per capita growth as a measure for cycles, Hakura’s findings broadly align with those in Kose et al. [2003]: country-specific and idiosyncratic factors account for 74% to 83% of fluctuations in emerging economies, whereas that figure declines to 40% to 54% for developed countries. Karadimitropoulou and León-Ledesma [2013] use sector-specific factors in order to account for business-cycle synchronisation, and find similar results. Their model describes three factors: global, country-specific and sector-specific factors, as well as an idiosyncratic component. The find that sector-specific and country-specific factors account for the bulk of business cycle co-movements, whereas the world factor is not significant. Similar observations can be made as to standard deviation output growth as a stand-in for macroeconomic fluctuations in emerging economies. Their limitations further buttress our choice of a de-trended output measure instead. Furthermore, the literature’s focus on developed economies. The more recent literature focuses on alternative transmission channels of global shocks to individual economies. Fernández et al. [2018] focus on fluctuations in commodity prices and transmission channels of their macroeconomic impact on emerging economies. They show that fluctuations in commodity prices generate shocks that account for 42% of output variance in emerging economies. Although our nonparametric specification does not allow for commodity prices, the authors’ results can be interpreted as an alternative proxy for a global factor, in their case oil prices.

Fernández et al. [2018] estimate a structural VAR model over a sample of 189 countries of different income levels. They show that commodity prices display strong correlation with the business cycle in these economies, and prove that there is a common dynamic factor to account for both. Fernández et al. [2017] offer similar conclusions, and posit that global shocks are correlated to terms of trade and the world interest rate. They show that the world factor accounts for 23% to 37% of output fluctuations, a slightly lower estimate in comparison to our own. Fernández et al. [2017] notice however that the world factor contribution in output variance doubles after 2000. They attribute this increase in variance decomposition to changes in
domestic transmission channels, as well as increased openness to global trade and financialisation of world commodity markets. Their comments suggest that our nonparametric-based estimations of global and regional factors are quite sensitive to these changes in global trade and financial flows.

2.3 Descriptive statistics & stylised facts

Data description

The country set sample is built using available open sources. We use the World Bank [2018] World Development Indicators (WDI) and the Groningen Growth & Development Center database developed by Feenstra et al. [2015] (formerly the Penn World Table - PWT). The dataset runs from 1960 to 2013. The sample set of 100 countries are broken down into regional sub-sets, as well as income category groups. We use the World Bank Atlas method to identify High-income countries (as a proxy for developed economies and a benchmark) and the rest as various proxies for emerging countries.

Stylised facts

The study of macroeconomic fluctuations seeks to identify the cyclical components of macroeconomic variables. The literature relies frequently on the Hodrick and Prescott [1997] (HP) filter to decompose aggregates of interest between their trend and cyclical components. The HP filter identifies mid-frequency fluctuation levels, which are more usually associated with business cycles. Despite its easy implementation, some caution needs to be exercised: Harvey and Jaeger [1993] explain that HP-filtered data may display spurious cyclical properties, and state correlations where there are none. Nevertheless, the HP filter is better suited than its competitors, for instance the Baxter and King [1999] filter is more versatile, but tends to discard data points at both extremites of the time sample. In their introduction of business cycles stylised facts for developed and emerging economies, Schmitt-Grohé and Uribe [2017] apply a quadratic filter in order to isolate the cyclical components of macroeconomic variables. When using the HP filter on annual data, they adopt a smoothing parameter \( \lambda = 100 \). We argue that this value overstates the cyclical component on all countries in their sample set. By contrast, we adopt the smoothing parameter value put forward by Ravn and Uhlig [2002] and calibrate the cycle for annual data by setting \( \lambda = 6.24 \).

![Figure 2.1: Boxplots for standard deviation of de-trended output per capita - group categories.](image)

**Note:** Boxplots use logged real GDP per capita for the period 1960-2013 for 100 countries. The HP filter is used to de-trend output, using smoothing parameter \( \lambda = 6.24 \) for annual data. Countries in the sample set are fitted into regional groups excluding High-income countries. The income-based categories use the World Bank Atlas method.
Figure 2.1 offers a first-hand illustration of the heterogeneity in macroeconomic fluctuations, regardless of income level and geographical distribution. The OECD group exhibits not only the lowest levels of output volatility, but also the smallest level of dispersion around its group mean. By contrast, regional groups like Sub-Saharan Africa, Middle-East & North Africa (MENA) and Eastern Europe & Central Asia exhibit higher average values for standard deviation of de-trended output, and higher variance. Other regional groups such as South Asia and Latin America exhibit smaller levels of dispersion around their respective group means. This is observed on the boxplot, even as their respective levels of output volatility are higher than those of the OECD group mean. Income-wise, group categories appear to exhibit similar levels of variance, which means that differences among group categories are mostly about their respective average values. The poorest countries exhibit the highest levels of output fluctuations, measured as the standard deviation of de-trended output. We also observe that there appear to be little to no difference in mean group levels of output volatility between the two groups for middle-income countries, Middle-low and Middle-high following the World Bank Atlas method.

We report in tables 2.1 and 2.2 below the summary statistics of moments that are considered in the literature as standard stylised facts.

Table 2.1: Summary statistics: HP-filtered aggregates and moments of interest (Regional groups).

<table>
<thead>
<tr>
<th>Region</th>
<th>$g_y$</th>
<th>$\sigma_y$</th>
<th>$\sigma_c$</th>
<th>$\rho_{y,z}$</th>
<th>$\rho_{y, tb}$</th>
<th>$\rho_{y,c}$</th>
<th>$\rho_{tb}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>OECD</td>
<td>0.025</td>
<td>0.024</td>
<td>0.028</td>
<td>0.180</td>
<td>-0.031</td>
<td>0.681</td>
<td>0.541</td>
</tr>
<tr>
<td>Std.dev.</td>
<td>(0.010)</td>
<td>(0.011)</td>
<td>(0.014)</td>
<td>(0.091)</td>
<td>(0.128)</td>
<td>(0.197)</td>
<td>(0.235)</td>
</tr>
<tr>
<td>N</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>21</td>
<td>24</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>0.013</td>
<td>0.046</td>
<td>0.067</td>
<td>0.212</td>
<td>-0.003</td>
<td>0.569</td>
<td>0.380</td>
</tr>
<tr>
<td></td>
<td>(0.016)</td>
<td>(0.016)</td>
<td>(0.051)</td>
<td>(0.093)</td>
<td>(0.182)</td>
<td>(0.289)</td>
<td>(0.249)</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>17</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>South Asia &amp; Pacific</td>
<td>0.039</td>
<td>0.032</td>
<td>0.040</td>
<td>0.250</td>
<td>-0.086</td>
<td>0.650</td>
<td>0.447</td>
</tr>
<tr>
<td></td>
<td>(0.016)</td>
<td>(0.011)</td>
<td>(0.021)</td>
<td>(0.151)</td>
<td>(0.102)</td>
<td>(0.206)</td>
<td>(0.227)</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>11</td>
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<td>12</td>
</tr>
<tr>
<td>Latin America &amp; Caribbean</td>
<td>0.018</td>
<td>0.031</td>
<td>0.039</td>
<td>0.216</td>
<td>0.010</td>
<td>0.711</td>
<td>0.466</td>
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<tr>
<td></td>
<td>(0.007)</td>
<td>(0.009)</td>
<td>(0.015)</td>
<td>(0.127)</td>
<td>(0.119)</td>
<td>(0.176)</td>
<td>(0.203)</td>
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<tr>
<td></td>
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<td>19</td>
<td>19</td>
<td>15</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>MENA</td>
<td>0.021</td>
<td>0.048</td>
<td>0.051</td>
<td>0.243</td>
<td>-0.053</td>
<td>0.535</td>
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<td></td>
<td>(0.009)</td>
<td>(0.015)</td>
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<td>(0.086)</td>
<td>(0.126)</td>
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<td>(0.179)</td>
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<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>E. Europe &amp; C. Asia</td>
<td>0.025</td>
<td>0.046</td>
<td>0.056</td>
<td>0.335</td>
<td>0.048</td>
<td>0.720</td>
<td>0.434</td>
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<tr>
<td></td>
<td>(0.016)</td>
<td>(0.017)</td>
<td>(0.024)</td>
<td>(0.146)</td>
<td>(0.231)</td>
<td>(0.199)</td>
<td>(0.159)</td>
</tr>
<tr>
<td></td>
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<td>14</td>
<td>14</td>
<td>14</td>
<td>13</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>World</td>
<td>0.022</td>
<td>0.037</td>
<td>0.046</td>
<td>0.230</td>
<td>-0.016</td>
<td>0.650</td>
<td>0.469</td>
</tr>
<tr>
<td></td>
<td>(0.014)</td>
<td>(0.016)</td>
<td>(0.031)</td>
<td>(0.122)</td>
<td>(0.155)</td>
<td>(0.231)</td>
<td>(0.220)</td>
</tr>
<tr>
<td></td>
<td>99</td>
<td>100</td>
<td>100</td>
<td>88</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Note: Sample set of 100 countries on annual data 1960-2013. Variables of interest are logged and de-trended using the HP filter with $\lambda = 6.24$. Variable $g_y$ denotes real average growth rate per capita. Variables $\sigma_y$, $\sigma_c$ refer respectively to de-trended real GDP per capita, and real household expenditure per capita. The remaining variables $\rho_{y,z}$, $\rho_{y, tb}$ and $\rho_{y,c}$ refer to the contemporaneous coefficients of correlation between output, productivity, the trade balance-to-output ratio and consumption, respectively. Productivity is measured as the Solow residual computed in the PWT database. Variable $\rho_{tb}$ refers to the persistence of the trade balance-to-output ratio, which is computed from the auto-correlation function of this variable. Standard errors are reported in brackets.

Tables 2.1 and 2.2 report summary statistics for the main moments that describe macroeconomic fluctuations. Table 2.1 breaks down the country sample set into regional groups, and
uses the OECD group category as a proxy for developed economies. We use this group as the benchmark comparison to the regional groups that represent sub-categories of emerging countries. The first column reports average growth of real GDP per capita. Countries in South Asia & Pacific exhibit the highest level at almost 4% over the period 1960-2013. By contrast, Sub-Saharan Africa and Latin America experience comparatively lower average levels of growth, respectively at 1.3% and 1.8%. The OECD benchmark group exhibits an average growth of 2.5%. These mean-group levels are representative of their individual components, thanks to the comparatively low values of standard deviation reported on table 2.1. This also report for the standard deviation of de-trended output. On average, output volatility is lowest in the OECD benchmark group, at 2.4%. This figure contrasts with the higher levels of output fluctuations in Sub-Saharan Africa, MENA and Eastern Europe & Central Asia. Their respective average standard deviations of output fluctuation are reported on the range of 4.6% and 4.8%. The differences between developed and emerging economies are starker as far as consumption volatility is concerned. Sub-Saharan Africa, MENA and Eastern Europe all exhibit significantly higher levels of mean-group volatility in household expenditure. All regional groups also report a higher level of consumption volatility in comparison with output fluctuations. The difference is quite low for the OECD group, with consumption volatility $\sigma_c$ 16% higher than de-trended output standard deviation $\sigma_y$. The ratio is significantly higher in other regional groups of emerging economies, such as Sub-Saharan Africa, where household expenditure is almost 50% more volatile than output. The differences between developed economies on the one side, and emerging countries on the other, are not as clear-cut for the other macroeconomic indicators. The correlation between output fluctuations and productivity is similar across regional groups. Although the OECD exhibits a comparatively low correlation at .180, they are not far off other regional groups, such as Latin America or Sub-Saharan Africa, respectively at .216 and .212. Eastern Europe & Central Asia appear to exhibit a much higher correlation at .335, though it also has a comparatively higher standard deviation. Correlation between output and household expenditure is much more homogenous, where sample-wide average correlation is at .650, and mean-groups are found on the range .535 and .720. A stylised fact that seems to be widely shared among the country in our sample is that consumption and output are relatively well correlated: figures for $\rho_{c,y}$ show there is little dispersion around the global average correlation level of .637, with high levels in Latin America and OECD at respectively .711 and .705, and low levels in Sub-Saharan Africa, at .581. Only the MENA regional group displays a low correlation level of .426. Additionally, levels of correlation between output and productivity $\rho_{z,y}$ seem to be closely similar in all five category groups, where the global average correlation of .230 is almost universal among all groups. A similar observation can be made regarding the persistence of the trade balance $\rho_{tb}$, comparatively strong and almost uniformly distributed among the regional group samples. OECD and MENA both exhibit the highest persistence levels at respectively .520 and .562. These similarities are not however reported for the correlation between this aggregate and output. Most regional groups exhibit negative correlation levels, but they have large standard deviations, which does not allow for intuitive comparisons.

Table 2.2 reports the same results for income-based group categories. Almost all indicators are common and are homogenous across income category groups. For aggregate fluctuations, and in contrast with regional groups, there are clear differences in terms of growth rate levels, with High and Middle-high income countries exhibiting the highest levels of growth in real GDP per capita. This result should be contrasted with the group mean of Low income countries, which is not only very low at 0.7%, but also exhibits a large standard deviation of .012. The Low income country group is also different from the other income categories, in that it exhibits high levels of output and household expenditure volatility. The ratio of the two moments is highest in the Low income category, and we can see that it narrows as the income category becomes wealthier.
Table 2.2: Summary statistics: HP-filtered aggregates and moments of interest (Income category groups).

<table>
<thead>
<tr>
<th>Region</th>
<th>$g_y$</th>
<th>$\sigma_y$</th>
<th>$\sigma_c$</th>
<th>$\rho_{y,z}$</th>
<th>$\rho_{y,tb}$</th>
<th>$\rho_{y,c}$</th>
<th>$\rho_{tb}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Income</td>
<td>0.026</td>
<td>0.033</td>
<td>0.038</td>
<td>0.231</td>
<td>-0.022</td>
<td>0.660</td>
<td>0.516</td>
</tr>
<tr>
<td>Std.dev.</td>
<td>(0.012)</td>
<td>(0.015)</td>
<td>(0.021)</td>
<td>(0.124)</td>
<td>(0.164)</td>
<td>(0.237)</td>
<td>(0.207)</td>
</tr>
<tr>
<td>N</td>
<td>47</td>
<td>48</td>
<td>48</td>
<td>42</td>
<td>48</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>Upper Middle Income</td>
<td>0.026</td>
<td>0.040</td>
<td>0.046</td>
<td>0.254</td>
<td>-0.017</td>
<td>0.684</td>
<td>0.477</td>
</tr>
<tr>
<td>Std.dev.</td>
<td>(0.014)</td>
<td>(0.015)</td>
<td>(0.022)</td>
<td>(0.153)</td>
<td>(0.146)</td>
<td>(0.202)</td>
<td>(0.203)</td>
</tr>
<tr>
<td>N</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>22</td>
<td>25</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Lower Middle Income</td>
<td>0.015</td>
<td>0.035</td>
<td>0.043</td>
<td>0.211</td>
<td>-0.010</td>
<td>0.656</td>
<td>0.397</td>
</tr>
<tr>
<td>Std.dev.</td>
<td>(0.013)</td>
<td>(0.016)</td>
<td>(0.021)</td>
<td>(0.088)</td>
<td>(0.150)</td>
<td>(0.131)</td>
<td>(0.230)</td>
</tr>
<tr>
<td>N</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>15</td>
<td>17</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Low Income</td>
<td>0.007</td>
<td>0.050</td>
<td>0.084</td>
<td>0.202</td>
<td>-0.001</td>
<td>0.508</td>
<td>0.347</td>
</tr>
<tr>
<td>Std.dev.</td>
<td>(0.012)</td>
<td>(0.017)</td>
<td>(0.065)</td>
<td>(0.067)</td>
<td>(0.170)</td>
<td>(0.353)</td>
<td>(0.256)</td>
</tr>
<tr>
<td>N</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>9</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>World</td>
<td>0.022</td>
<td>0.037</td>
<td>0.046</td>
<td>0.230</td>
<td>-0.016</td>
<td>0.650</td>
<td>0.469</td>
</tr>
<tr>
<td>Std.dev.</td>
<td>(0.014)</td>
<td>(0.016)</td>
<td>(0.031)</td>
<td>(0.122)</td>
<td>(0.155)</td>
<td>(0.231)</td>
<td>(0.220)</td>
</tr>
<tr>
<td>N</td>
<td>99</td>
<td>100</td>
<td>100</td>
<td>88</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Note: See comments on table 2.1.

The cross-group income differences in fluctuations may be endogenous to the level of real income per capita. As reported in Schmitt-Grohé and Uribe [2017], output volatility decreases in logged output per capita. By contrast, the fact that a given country belongs to a given region is exogenous to its macroeconomic fluctuations. As a result, we argue that regional groups are a more appropriate category criteria to adopt in order to depict stylised facts and their differences between emerging and developed countries.

Since those stylised facts are delineated by region, it would make sense to check whether differences in those indicators (as well as others) exist, or are significant. Consequently we use ANOVA techniques to pinpoint differences within the EMEs with respect to the OECD country group, which is treated as the base level. In addition to the indicators displayed in table 2.1 we also introduce persistence of the trade balance. These observations cannot state definitively that output is uniformly more volatile in emerging economies in comparison with developed ones, or that there are no significant discrepancies in consumption-output correlation levels. In fact, any comparison between moments and stylised facts across country groups needs to be statistically robust, which invites multivariate testing methods. We apply ANOVA techniques in order to check on statistically significant differences across regional samples, and use the OECD set as the base level benchmark.

ANalysis Of VAriance (ANOVA) applies to a heterogeneous sample, in our case matching moments of macroeconomic variables. We test the hypothesis that the macroeconomic aggregates reported for our sample set will differ across regional groups. In particular, we test whether there are statistically significant differences within those country groups we have created out of geographical sub-sets. In essence, the null hypothesis of this multivariate t-test is to posit that $\mu_1 = \mu_2 = \cdots = \mu_5$ where $\mu_i$ is the moment of interest for country group $i$. The same reasoning applies in an ANOVA regression, where a base level benchmark is compared against the other group categories. The ANOVA regression results in table 2.3 show there are significant differences between the individual category groups of emerging economies and the OECD country sample and justify the observation made in figure 2.1.

Using the OECD group category as a benchmark base level, table 2.3 reports that real growth per capita is significantly lower in Sub-Sahara Africa and Latin America & Caribbean. By contrast, the group mean growth rate of South Asia & Pacific is significantly higher, while MENA
Table 2.3: ANOVA Regression results: OECD group category as base level.

<table>
<thead>
<tr>
<th>Variable</th>
<th>$g_y$</th>
<th>$\sigma_y$</th>
<th>$\sigma_c$</th>
<th>$\rho_{y.z}$</th>
<th>$\rho_{y.tb}$</th>
<th>$\rho_{y.c}$</th>
<th>$\rho_{tb}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-Sahara Africa</td>
<td>-0.012***</td>
<td>0.022***</td>
<td>0.039***</td>
<td>0.032</td>
<td>0.028</td>
<td>-0.112</td>
<td>-0.161***</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.009)</td>
<td>(0.035)</td>
<td>(0.05)</td>
<td>(0.069)</td>
<td>(0.066)</td>
</tr>
<tr>
<td>South Asia &amp; Pacific</td>
<td>0.014***</td>
<td>0.008*</td>
<td>0.012</td>
<td>0.070*</td>
<td>-0.055</td>
<td>-0.031</td>
<td>-0.094</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
<td>(0.005)</td>
<td>(0.01)</td>
<td>(0.041)</td>
<td>(0.058)</td>
<td>(0.08)</td>
<td>(0.077)</td>
</tr>
<tr>
<td>Latin Am. &amp; Carib.</td>
<td>-0.007*</td>
<td>0.007*</td>
<td>0.011</td>
<td>0.036</td>
<td>0.041</td>
<td>0.03</td>
<td>-0.075</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.009)</td>
<td>(0.035)</td>
<td>(0.052)</td>
<td>(0.07)</td>
<td>(0.067)</td>
</tr>
<tr>
<td>MENA</td>
<td>-0.004</td>
<td>0.023***</td>
<td>0.023***</td>
<td>0.063</td>
<td>-0.022</td>
<td>-0.146*</td>
<td>0.011</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
<td>(0.005)</td>
<td>(0.01)</td>
<td>(0.042)</td>
<td>(0.058)</td>
<td>(0.082)</td>
<td>(0.079)</td>
</tr>
<tr>
<td>E. Europe &amp; C. Asia</td>
<td>0.003</td>
<td>0.022***</td>
<td>0.028***</td>
<td>0.155***</td>
<td>0.079</td>
<td>0.039</td>
<td>-0.107</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.005)</td>
<td>(0.01)</td>
<td>(0.039)</td>
<td>(0.055)</td>
<td>(0.076)</td>
<td>(0.073)</td>
</tr>
<tr>
<td>Intercept</td>
<td>0.025***</td>
<td>0.024***</td>
<td>0.028***</td>
<td>0.180***</td>
<td>-0.031</td>
<td>0.681***</td>
<td>0.541***</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.006)</td>
<td>(0.023)</td>
<td>(0.034)</td>
<td>(0.046)</td>
<td>(0.044)</td>
</tr>
<tr>
<td>R²</td>
<td>0.273</td>
<td>0.342</td>
<td>0.203</td>
<td>0.157</td>
<td>0.067</td>
<td>0.083</td>
<td>0.079</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.234</td>
<td>0.307</td>
<td>0.161</td>
<td>0.112</td>
<td>0.009</td>
<td>0.035</td>
<td>0.031</td>
</tr>
<tr>
<td>RMSE</td>
<td>0.013</td>
<td>0.013</td>
<td>0.028</td>
<td>0.115</td>
<td>0.155</td>
<td>0.226</td>
<td>0.217</td>
</tr>
<tr>
<td>RSS</td>
<td>0.015</td>
<td>0.017</td>
<td>0.076</td>
<td>1.245</td>
<td>1.959</td>
<td>4.822</td>
<td>4.411</td>
</tr>
<tr>
<td>Log-likelihood</td>
<td>294.972</td>
<td>292.499</td>
<td>217.304</td>
<td>77.415</td>
<td>42.537</td>
<td>9.704</td>
<td>14.158</td>
</tr>
</tbody>
</table>

Note: Each regression reports its summary statistics for $R^2$, residual mean square error (RMSE) and residual squared sum (RSS). Estimated coefficients report the group-mean differences, which are tested against a null hypothesis, using a pairwise t-test. P-value coefficients legend: * 10% ** 5% *** ≤ 1%. Standard errors are reported in brackets. For additional comments, see table 2.1.

and Eastern Europe & Central Asia do not appear to experience higher group mean growth rate in comparison with developed economies. Output in MENA and Sub-Saharan Africa fluctuates much more than that in the OECD, with all group-wise differences at statistically significant levels. By contrast, cross-group differences with the OECD benchmark for the standard deviation of de-trended household expenditure are more ambiguous. South Asia and Latin America appear to exhibit no significant differences with respect to the OECD group mean. These results suggest the existence of significant differences within emerging economies, something the literature has glanced over. For instance, Aguiar and Gopinath [2007] in their study of business cycles in emerging economies find that consumption is more volatile than output in Latin American economies, and extend these findings to all emerging economies as a common stylised fact. Schmitt-Grohé and Uribe [2017] also argue this point, even as their result suggest that developed economies can also experience excess volatility in household expenditure relative to output. Group heterogeneity is not observed with the same consistency in household consumption fluctuations: Only the Sub-Saharan Africa sample group displays significant differences with the OECD base comparison. This suggests household consumption fluctuations are not different in the other emerging economies when compared to the wealthier ones. This is additional evidence to doubt the literature’s wisdom in focusing on Latin America as a benchmark for developing economies and to extend those results. There are other stylised facts more widely shared among all regions: apart from MENA, levels of correlation between consumption and output are not significantly different from one region to the other in comparison to OECD. Still, correlation between output and consumption remains positive and fits into the core predictions of the real business cycle model. While ANOVA regression results test for differences from the OECD as a benchmark, and emerging country group sets, levels of correlation between output and the selected set of macroeconomic variables need to be checked further for homogeneity. In particular, the ANOVA results are based on the assumption that the individual components of group categories are drawn from a distribution with the same standard deviation. To that effect, we use the Levene and Brown & Forsythe test for equal variance to check whether this
assumption holds for our stylised facts. The Levene test assumes that all categories exhibit the same variance, and tests this assumption against the data. The Brown & Forsythe test computes the F statistic using either the median instead of the mean, or de-mean the data altogether.

Table 2.4: Levene variance test - whole sample.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>$W_0$</th>
<th>$W_{50}$</th>
<th>$W_{10}$</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$g_y$ Growth per capita</td>
<td>1.974</td>
<td>1.708</td>
<td>1.818</td>
<td>0.089</td>
</tr>
<tr>
<td>$\sigma_y$ Std.dev. output</td>
<td>2.067</td>
<td>1.915</td>
<td>2.053</td>
<td>0.076</td>
</tr>
<tr>
<td>$\sigma_c$ Std.dev. consumption</td>
<td>2.921</td>
<td>2.105</td>
<td>2.208</td>
<td>0.016</td>
</tr>
<tr>
<td>$\rho_{y,z}$ Correlation TFP, output</td>
<td>1.296</td>
<td>1.021</td>
<td>1.165</td>
<td>0.272</td>
</tr>
<tr>
<td>$\rho_{y, tb}$ Correlation trade balance, output</td>
<td>2.758</td>
<td>2.611</td>
<td>2.796</td>
<td>0.023</td>
</tr>
<tr>
<td>$\rho_{y, c}$ Correlation consumption, output</td>
<td>0.918</td>
<td>0.744</td>
<td>0.823</td>
<td>0.591</td>
</tr>
<tr>
<td>$\rho_{tb}$ Persistence - trade balance</td>
<td>0.908</td>
<td>0.762</td>
<td>0.903</td>
<td>0.484</td>
</tr>
</tbody>
</table>

**Note:** The Levene test is used to check if the group categories experience equal variances. It is a more general expression of the Bartlett test, and is thus less sensitive to non-normally distributed data. The test compares the group-wise mean and standard deviation of each regional group, and tests whether all cross-group variances are equal. For $k$ groups, the null hypothesis of the Levene test posits that $\sigma_1 = \sigma_2 = \ldots = \sigma_k$. The alternative hypothesis is that at least a couple $(i,j)$ exhibit different variances. Column $W_0$ reports the Fisher statistic of the Levene test. Columns $W_{50}$ and $W_{10}$ refers respectively to the test using the median instead of the mean, and a de-meaned statistic. Both variants are the Brown and Forsythe’s F statistic. The p-value is computed from the comparison of the Levene $W_0$ F statistic against its theoretical value.

Using a 5% threshold, we do not reject the null hypothesis that variances are equal across regional groups, except for two indicators. The p-value was below the threshold for the standard deviation of household expenditure, $\sigma_c$, as well as the correlation between output and the trade balance ratio, $\rho_{y, tb}$. In other words, we can argue that apart from these two indicators, the ANOVA results for the selected set of stylised facts are robust as they are built on the assumption of group-wise equal variances. Nevertheless, a rule of thumb put forward by [Rogan and Keselman 1977](#) suggest that as long as the ratio of the largest and smaller variances in the group categories is lower than 4, then the ANOVA assumptions hold. Note that for moments $\sigma_c$ and $\rho_{y, tb}$, variances are indeed more heterogenous, but the differences are not as large as the rule of thumb specifies. The largest variance for the correlation between the trade balance ratio and output is .231 vs. the smallest at .101. The same can be reported for household expenditure volatility, $\sigma_c$ with .051 and .015 the range of group-wise variances.

The main takeaway from the stylised facts enumerated above is that differences between emerging and developed economies stop at output fluctuations, other macroeconomic variables are much more ambiguous, as far as statistically significant results show. The fact that the business cycle is more volatile in emerging economies is a well-documented stylised fact in the literature; other macroeconomic variables behave in a much more nuanced fashion. Standard deviation of the de-trended household expenditure is more ambiguous, and contradicts the literature’s assertion that high values are only observed in emerging economies. The group categories also exhibit regular properties, a result that may lead credence to the points made by [Lucas 1977](#) and [Agénor et al. 2000](#) in their respective conclusions.
Stylised facts - trade autocorrelation and cycle synchronisation

This initial investigation of stylised facts among emerging economies has provided an important set of evidence: it shows that while output fluctuates significantly more in emerging economies than it does in wealthier ones, other aggregates follow different patterns. Specifically, we find that output correlation with variables such as trade balance and technological progress correlation to output are much more homogeneous than expected. These two stylised facts lend credence to the assertions made by Agénor et al. [2000] that macroeconomic fluctuations are strikingly similar between developed and emerging countries. We are interested in particular in potential differences between developed and emerging economies with respect to the trade balance-to-output ratio. Figure 2.2 reports the autocorrelation function for each regional group, and offers comparison with respect to the developed economies country group. We are also interested in its autocorrelation function across the country groups. Figure 2.2 plots autocorrelation functions (ACF) for trade balance-to-output ratio for each individual country, and these are consolidated into their respective regional groups. All regional groups exhibit a strong persistence in their respective median trade balance-to-output ratio, a feature observed and discussed at length in García-Cicco et al. [2010a]. The authors argue that the trade balance ratio exhibits an ACF behaviour that is close to that of a random walk, where there is a strong autocorrelation even for higher orders. The fact that the OECD median ACF fits within the 25th and 75th percentiles of most regional groups is further testimony to the homogeneity of trade balance ratio in our sample set.

Figure 2.2: Trade Balance-to-output ratio autocorrelation - regional groups.

Note: The trade balance-to-output ratio autocorrelation function (ACF) is computed for each individual country in the sample set over ten periods. The figure reports group median ACF with the 25th and 75th percentiles. Each subplot compares the regional group median against the OECD baseline group.

Despite the strong similarities in ACFs between the OECD and other regional groups, some differences linger nevertheless. Even as all regional groups at a very high level - close to unity - ACF functions in emerging economies decline at a faster pace. Eastern Europe & Central Asia exhibits the closest behaviour to that of the OECD benchmark country group. By the 10th
period, the autocorrelation level is around 0.3 for both regional groups. By contrast, the ACF function diverges fairly quickly between MENA and OECD groups. The same can be observed for Latin America & Caribbean, as well as South Asia & Pacific. All three regional groups start at high levels in the first couple of periods. By the fourth period, the median ACF functions between the OECD on the one hand, and any of the three regional groups on the other hand diverge rapidly. The three emerging economies' country groups converge quickly to zero for the next set of periods. By contrast, Sub-Sahara Africa appears to imitate the same properties reported for Eastern Europe & Central Asia. These results underline the ambiguous properties of trade balance ratio in emerging economies compared to developed ones. On the one hand, there are strong similarities with the quasi-random walk properties of the trade balance ratio, a feature reported and discussed by García-Cicco *et al.* [2010a]. These similarities reinforce the assertions of Lucas [1977] that the business cycles are similar across the world regardless of region or income level, or that there are regularities in the business cycles of emerging economies, according to Agénor *et al.* [2000]. On the other hand, these similarities fade fairly quickly in the subsequent periods, and there are significant differences across regional groups for emerging economies.

**Determinants of output fluctuations**

In their study of business cycles across a large country sample, Schmitt-Grohé and Uribe [2017] have identified and compiled a number of stylised facts. We focus in particular on those stylised facts regarding the magnitude differences in output fluctuations between developing and developed economies. The authors observe that larger and wealthier economies experience low output volatility. In order to test for statistical significance, they run a simple regression of standard deviation output per capita over openness to trade, measured as the sum of exports and imports over GDP, as well as the log of population and real GDP per capita. Their regression shows that larger economies - both in terms of population and wealth- tend to exhibit lower output volatility. By contrast, openness to trade however is more closely associated with increased volatility. We carry out a similar regression by testing whether openness to trade, global and regional, can reduce output volatility. We stress that this specification is not offered as a definitive, or exhaustive model framework. It should be construed within this paper’s focus on collecting as many stylised facts as possible for emerging economies, and compare them against well-established facts for developed ones. To that effect, we regress standard deviation the detrended output on openness to trade, measured as the sum of exports and imports relative to output, the share of intra-regional trade, the log real GDP per capita and correlation between output and government expenditure. We also introduce a regional dummy to check on the existence of regional explanatory factors as well. The results of our regressions are reported in table 2.5.

Our results are similar to those reported in Fernández *et al.* [2017] with regards to openness to trade. The regression results reported in table 2.5 show that output in open economies experiences higher volatility. Similarly, larger economies tend to exhibit a smoother business cycle, as measured by the de-trended output standard deviation. We have also controlled for a regional effect in our regressions, and these affect significantly the estimator for GDP per capita. Column (2) reports regression results with regional dummies incorporated, and shows that log GDP per capita is no longer a statistically significant estimator. By contrast, when de-trended household expenditure standard deviation is included, it shows a consistent result with real business-cycle literature and stylised facts. We also show that discretionary fiscal policy, captured by correlation between GDP and government expenditure, also contributes to output volatility.
Table 2.5: Determinants of de-trended output fluctuations: OLS regression results.

<table>
<thead>
<tr>
<th>Variable</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Openness to Trade</td>
<td>0.013**</td>
<td>0.011*</td>
<td>0.005</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
<td>(0.005)</td>
<td>(0.004)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>Intra-regional trade (%)</td>
<td>-0.066*</td>
<td>-0.063*</td>
<td>-0.062**</td>
<td>-0.068**</td>
</tr>
<tr>
<td></td>
<td>(0.027)</td>
<td>(0.028)</td>
<td>(0.023)</td>
<td>(0.023)</td>
</tr>
<tr>
<td>Log GDP per Capita</td>
<td>-0.006**</td>
<td>-0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.002)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household consumption volatility</td>
<td>0.288***</td>
<td>0.309***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.053)</td>
<td>(0.053)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correlation GDP/Government expenditure</td>
<td>0.015*</td>
<td></td>
<td>0.012*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td></td>
<td>(0.005)</td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.085***</td>
<td>0.032***</td>
<td>0.018***</td>
<td>0.012*</td>
</tr>
<tr>
<td></td>
<td>(0.017)</td>
<td>(0.022)</td>
<td>(0.004)</td>
<td>(0.005)</td>
</tr>
<tr>
<td>Regional Dummies</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Sample</td>
<td>101</td>
<td>101</td>
<td>101</td>
<td>99</td>
</tr>
<tr>
<td>R2</td>
<td>0.132</td>
<td>0.296</td>
<td>0.466</td>
<td>0.496</td>
</tr>
<tr>
<td>RMSE</td>
<td>0.022</td>
<td>0.02</td>
<td>0.018</td>
<td>0.017</td>
</tr>
<tr>
<td>RSS</td>
<td>0.048</td>
<td>0.039</td>
<td>0.029</td>
<td>0.027</td>
</tr>
<tr>
<td>Fisher F</td>
<td>3.497</td>
<td>5.598</td>
<td>11.609</td>
<td>11.0651</td>
</tr>
</tbody>
</table>

Note: De-trended output is regressed over explanatory variables, domestic and foreign indicators. Endogenous and explanatory variables are computed as average values are computed for the period 1960-2013. Regional dummies are indicator variables for the country groups of our sample set. p-value coefficients legend: * 10% ** 5% *** ≤ 1%. Standard errors are reported in brackets. Each regression reports its summary statistics for R^2, residual mean square error (RMSE) and residual squared sum (RSS).

2.4 Global, regional and country-specific factors

As the previous section fairly demonstrates, fluctuations in the EMEs are larger than those in the OECD. Although the section above provided exhaustive results for the stylised facts common across and specific to category groups, we do not know yet whether these discrepancies is due to purely domestic shocks, or to global and regional shocks these economies have difficulty mitigating. As discussed above, small open economies are subjected to a variety of exogenous shocks, domestic and external. The data does not however differentiate between global, regional and country-specific shocks, which means that an estimate must be computed for each factor, and then a further estimation needs to be conducted to account for the contribution of each factor to macroeconomic fluctuations.

Kose et al. [2003] investigate the contributions of global, regional and country-specific factors in growth fluctuations among G7 economies and compare those for a selected sample of emerging economies. Their results show that economies with low growth volatility are more sensitive to the world fact, singling out high-income economies. Hakura [2009] investigates the effects of foreign and domestic factors in emerging economies, and draws policy recommendations to benefit from smoothing output fluctuations. The author’s result show that domestic factors are significant in accounting for growth volatility in emerging economies. A less discretionary fiscal policy can yield substantial results in terms of cycle smoothing.

The literature referred to above uses standard deviation of real output per capita growth to carry out its computations of factor contribution to macroeconomic fluctuations. Its main drawback is to misrepresent the magnitude of aggregate fluctuations. In fact, GDP growth encompasses both cyclical and trend components, and this tends to overstate fluctuations as far as the EMEs are concerned. Growth trend in those economies is not as smooth as that of their wealthier counterparts, which may lead to distorted estimates for the contributions of

37
domestic and external shocks' to fluctuations. To illustrate this claim, we compute a 10-year rolling standard deviation of real GDP per capita growth from 1960 to 2011 against similarly computed 10-year rolling standard deviation of the HP-filtered log real GDP per capita. Figure 2.3 shows the two variables for four country groups. Growth is less volatile than cycles in the OECD country group only. All regional groups that are used as stand-in for emerging economies exhibit a larger degree of magnitude in growth than of fluctuations, and that provides a prime facie case to gainsay results admitted in the literature: Significantly more volatile output may fail to capture the proper components' respective contributions to cycles. In addition, the OECD economies exhibit a relatively low correlation of .214 between output and the cyclical component, in contrast to the correlations of other country groups, in Sub-Saharan Africa, Latin America and the MENA economies, respectively .737, .848 and .915. The unfiltered GDP per capital growth overstates fluctuations in emerging economies, and as a result will overestimate country-specific factors. Figure 2.4 illustrates the significant differences in trend growth between emerging and developed economies, regardless of the filtering technique used on the data.

Nonparametric smoothing and regression

Nonparametric estimation has been pioneered by Rosenblatt [1956] and expended by Parzen [1962] and Nadaraya [1965]. Racine [1997] implements it, which makes it a versatile tool for capturing unobservable global trends among all countries, and region-specific factors in the selected groups. The model specification does not impose a parametric functional form on the data, it seeks instead to divide it into chunks known as bandwidths akin to the histogram. Data smoothing is conducted with a weighting function whose properties are defined below, while bandwidths are computed to balance optimally between the amount of information it embeds and accurate estimation.

Formally, the observed data \( x_1, x_2, \ldots, x_n \) is treated as a sample following a distribution \( f \). The
Figure 2.4: Trend log GDP per capita: HP and polynomial filters.

Note: Data for the sample set covers the period 1960-2013. Trend components are computed using the HP filter with two values for the smoothing parameter \( \lambda \). The polynomial trend is computed following García-Cicco et al. [2010a]. Median values are reported for income-based categories, using the World Bank Atlas method. Middle-high and Middle-low income country groups are consolidated into one group.

Data sample is first represented by means of a histogram. The size of its bins is the outcome of a tradeoff between how much information is embedded in the selected size bin on the one hand, and its quality on the other. In their introduction of smoothing methods, Rawlings et al. [2001] stress the importance of these bandwidths in view of the compromise that needs to be achieved between data quality in these bins, and smoothing that may bring about the proper distinction between the hidden signal and the observed noise. Over-smoothing - that is, ordering the data in too few bins, leads to a biased estimator with a small variance, while under-smoothing with numerous and small bins leads to an estimator with small bias but large variance.

In this case, a measure of mean squared error is proposed to achieve the optimal bandwidth. MSE denoted \( \mathbb{E} \left[ \Omega \left( f(x), \hat{f}_n(x) \right) \right] \) writes:

\[
\Omega = \left[ f(x) - \hat{f}_n(x) \right]^2
\]  (2.4.1)

where \( f \) is the theoretical distribution, and \( \hat{f} \) is its estimated counterpart from a sample size \( n \). The mean square error may be broken down into two components:

\[
MSE = \mathbb{E} \left( \hat{f}_n(x) - f(x) \right)^2 + \mathbb{V} \left[ \hat{f}_n(x) \right]
\]  (2.4.2)

where the first term \( \mathbb{E} \left( \hat{f}_n(x) - f(x) \right)^2 \) denotes squared bias and the second variance. Optimal smoothing therefore seeks to minimise average risk in the bias-variance tradeoff.

We now turn to the properties of the smoothing function, the kernel is basically a weighting function \( K(u) \) with the following conditions to satisfy:

\[
\int K(u)du = 1
\]  (2.4.3)

\[
\int uK(u)du = 0
\]  (2.4.4)

\[
\forall u, K(-u) = K(u)
\]  (2.4.5)

\[
\sigma_K^2 = \int u^2K(u)du < \infty
\]  (2.4.6)

The kernel function estimation should result in a probability density function, zero-centered with equal weightings on either side, and with a finite positive variance.
Nonparametric regression therefore establishes a covariate relationship between pairs \((x_i, Y_i)\), where \(x_i\) and \(Y_i\) refer respectively to explanatory and endogenous variables written as:

\[ Y_i = r(x_i) + \epsilon_i \tag{2.4.7} \]

\(r(.)\) is a non-specified function that will be estimated with relaxed assumptions. We denote \(\hat{r}_n(x)\) its estimated sample counterpart. Two different methods will be used on country groups: the first step is to estimate a global factor among all countries, then a regional factor for the geographical groups. Once the world and regional factors are extracted from the data sample, we estimate their respective contributions to macroeconomic fluctuations by looking at output variance decomposition.

**Nonparametric regression**

Nonparametric regression does not impose the constraints of specifications upon the data. The estimation of regional and global factors is used instead of the standard dynamic factor model favoured by the literature due to the latter’s inability to generate a suitable common trend for countries in the sample. We proceed in two steps: first, the factors are computed with a robust LOWESS (Locally WEighted Scatterplot Smoothing) estimation for all 102 countries for the global factor. Each country group is taken separately, and their regional common trend is likewise estimated. Robust LOWESS is best for addressing outliers, as it allocates them smaller weightings, in comparison with other polynomial smoothing methods. Regional factors are then computed with the global trend reincorporated into each regional group to minimise the bias embedded in individual observations.

Due to the existence of significant outliers on the sample, a robust LOWESS estimation is more practical and relevant as a smoothing tool. We denote \(r_i\) as the residual at observation \(i\), and \(w_i\) its weight in the estimated polynomial. The former is written:

\[
w_i = \begin{cases} 
1 - \left( \frac{r_i}{6\sigma_m} \right)^2 & |r_i| < 6\sigma_m \\
0 & \text{otherwise}
\end{cases}
\tag{2.4.8}
\]

where \(\sigma_m\) refers to the median standard deviation. This means that the observations that are 6 standard deviations away from the median are outliers, and are therefore eliminated from the smoothing polynomial.

The long-run fluctuations illustrated in figure 2.5 capture global and region-specific fluctuations. The confidence interval bands are computed by bootstrapped nonparametric confidence bounds, following [Racine 1997]. The estimated global and regional factors are meaningful in view of historical events: starting from the mid-1980, global fluctuations abated significantly into the so-called *Great Moderation*. The slight uptick at the end of the time sample is due to the adverse effects of the 2008 financial crisis, a feature that can be readily observed in the OECD regional factor as well. The latter displays an earlier increase, which is due to the fact that OECD economies experienced the aftermath of the financial crisis more acutely than the rest of the world.

Sub-Saharan Africa and Latin American economies experienced strikingly similar patterns: increased factor fluctuations were quite persistent during the 1980s, an illustration of Kydland and Zarazaga [2002] *Lost Decade* episode shared by many countries in Latin America. However, the MENA and South Asia country groups exhibit different patterns: although both regions observed a decline in their fluctuations as well, the former comprises many oil-producing economies, and the second had to absorb the effects of the 1997 crisis. MENA economies are resource-rich, and their output is highly sensitive to commodity prices. As a result, the 1990s have been turbulent, due to a myriad of factors, among which the geopolitical context of the region. Countries in
South Asia shed their high-level fluctuations of the 1970s fairly quickly, and were well on track to catch up with OECD-levels of fluctuations. However, the financial crisis that affected many countries in South Asia in 1996-1997 generated a recession that kept fluctuations high well into the mid-2000s. Figure 2.5 shows two aspects of the behaviour of regional factors: first, many EMEs have managed to halve their fluctuations to near or below their initial values in the 1960s, yet their behaviour with respect to global fluctuations is heterogeneous. Second, regions that have already started out with high levels of fluctuations remain so: MENA and Sub-Saharan Africa remain respectively 24% and 32% more volatile than global factors, whereas the other regions remain 24% less volatile, 20% less when the OECD group is excluded.

Global and regional factor nonparametric regression

The two-step robust LOWESS provides a measure of goodness of fit similar to that of parametric linear models. Per Hayfield and Racine [2008] the alternative $R^2$ writes:

$$R^2_{np} = \frac{\sum_{i=1}^{n} (y_i - \bar{y})(\hat{y}_i - \bar{y})^2}{\sum_{i=1}^{n} (y_i - \bar{y})^2 \sum_{i=1}^{n} (\hat{y}_i - \bar{y})^2}$$ (2.4.9)

which is similar to the parametric $R^2$ obtained for the linear OLS-fitted model with an intercept. Given the nonparametric estimates embedded in the regional and global factors, the alternative $R^2$ is therefore likely to be more efficient given the local weighting estimation than its linear parametric counterpart, although there is always the risk that its superior goodness of fit may be due to over-fitting rather than a more adequate specification. Therefore the nonparametric regression conducted after the two-step LOWESS estimation seeks to provide an estimation for this specification:

$$\sigma^i_y = \alpha_1 \sigma^i_w + \alpha_2 \sigma^i_r + \alpha_3 \sigma^i_c + \epsilon_i$$ (2.4.10)
where $\sigma_w, \sigma_r, \sigma_c$ are, respectively, the world, region and country-specific factors for country $i$. As a result, the fraction of the business cycle due to world factor for instance would be:

\[
\frac{\alpha_2\sigma_w}{\sigma_y}\tag{2.4.11}
\]

and more generally:

\[
\forall z \in \{C, W, R\} \quad \sigma_z\% = \frac{\alpha_z\sigma_z}{\sigma_i}\tag{2.4.12}
\]

It is worth pointing out that we do not need to find the best estimate $\hat{\alpha}_z$ for (2.4.12). Rather, the nonparametric specification of (2.4.10) becomes:

\[
\sigma_y = r(\sigma_w, \sigma_r, \epsilon_i) + u(\epsilon_i, +\sigma_c)\tag{2.4.13}
\]

where the error term $u(.)$ incorporates country and idiosyncratic factors.\(^1\) The regression allows us to estimate the contribution of each factor to observed output variance, which means the $R^2$ measure takes over as the proxy for the contribution of each component. It is worth pointing out that estimates for the global and region-specific factors invariably exhibit some degree of covariance even when nonparametric estimation for regional factors include the global trend in the LOWESS regression. To that effect, we check the validity of both variables on the group samples, first by comparing them against the standard OLS estimation, and then by carrying out the battery of tests discussed in [Racine 1997] and [Racine and MacKinnon 2007]. Given that the nonparametric $R^2$ is always larger than its parametric counterpart, we test instead for over-fitting, in essence, check whether the nonparametric fitting over-explains the data and provides biased estimated for the global and regional trends.

As a result, we carry out nonparametric-specific statistical tests on the proposed specifications. Their chief role is to check whether the explanatory variables included in the nonparametric regression are significant, being the equivalent to a standard F-test in a regular regression setting, as documented [Racine et al. 2006] and [Racine 1997]. Significant bandwidth levels suggest that the smoothed data is meaningful, and in the context of the factor contribution to our measure of the business cycle, the selected factor is significant and well-specified. Table 2.6 lists partial $R^2$ for all category groups, as well as the residual country-specific contribution.\(^2\) It also provides the median p-values for the world and region factors bandwidths. These results from the two-steps nonparametric estimations are compared against results in [Hakura 2009] derived from a Bayesian dynamic factor model.

Differences from the results in the literature are multifarious: as mentioned earlier, the literature addresses growth volatility rather than cyclical fluctuations. Previous discussion about the shortcomings of the GDP growth standard deviation as a measure for business cycles showed significant discrepancy between the emerging and developed economies. The dynamic factor model adopted in the literature may overstate one factor compared to the other; the discussion concluded to the need for the use of de-trended aggregates, which is the case in this paper. Furthermore, the time frames are different: Our paper’s dataset is larger, more up-to-date and more exhaustive because it draws from more updated sources. A case in point is the comparison of the South Asia group, whose time frame is restricted to 1970-1996 as a way to isolate the 1997-1998 crisis. The nonparametric estimation is sensitive to the split time sample in a way that the literature does not show, particularly so in the regional factor, which accounts for nearly half the

---

\(^1\)for the sake of clarity, we assume that idiosyncratic are merged with country-specific factors

\(^2\)The absence of an asterisk does not mean that the country-specific factor is statistically nonsignificant. It is treated as a residual to the partial $R^2$ whose significance has been tested and displayed.
Table 2.6: Variance decomposition per global, regional and country-specific factors for output fluctuations.

<table>
<thead>
<tr>
<th>Country group</th>
<th>World</th>
<th>Region</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-Saharan Africa</td>
<td>37.3%***</td>
<td>34.6%**</td>
<td>27.9%</td>
</tr>
<tr>
<td></td>
<td>(.00)</td>
<td>(.03)</td>
<td></td>
</tr>
<tr>
<td>Kose et al. 2003</td>
<td>2.1%</td>
<td>4.3%</td>
<td>93.6%</td>
</tr>
<tr>
<td>Hakura 2009</td>
<td>6.2%</td>
<td>14.2%</td>
<td>79.1%</td>
</tr>
<tr>
<td>Fernández et al. 2017</td>
<td>32.0%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Middle-East &amp; North Africa</td>
<td>48.7%***</td>
<td>39.4%***</td>
<td>11.7%</td>
</tr>
<tr>
<td></td>
<td>(.01)</td>
<td>(.00)</td>
<td></td>
</tr>
<tr>
<td>Kose et al. 2003</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Hakura 2009</td>
<td>3.8%</td>
<td>15.9%</td>
<td>80.3%</td>
</tr>
<tr>
<td>Fernández et al. 2017</td>
<td>21.0%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Latin America &amp; Caribbean</td>
<td>45.5%*</td>
<td>32.2%***</td>
<td>22.2%</td>
</tr>
<tr>
<td></td>
<td>(.09)</td>
<td>(.00)</td>
<td></td>
</tr>
<tr>
<td>Kose et al. 2003</td>
<td>14.1%</td>
<td>1.5%</td>
<td>84.4%</td>
</tr>
<tr>
<td>Hakura 2009</td>
<td>12.6%</td>
<td>13.7%</td>
<td>73.7%</td>
</tr>
<tr>
<td>Fernández et al. 2017</td>
<td>43.0%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>South Asia &amp; Pacific</td>
<td>37.3%**</td>
<td>53.6%***</td>
<td>8.4%</td>
</tr>
<tr>
<td></td>
<td>(.01)</td>
<td>(.00)</td>
<td></td>
</tr>
<tr>
<td>Kose et al. 2003</td>
<td>5.2%</td>
<td>3.3%</td>
<td>91.5%</td>
</tr>
<tr>
<td>Hakura 2009</td>
<td>15.6%</td>
<td>20.6%</td>
<td>63.8%</td>
</tr>
<tr>
<td>Fernández et al. 2017</td>
<td>47.0%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(1970-1996)</td>
<td>41.7%</td>
<td>30.3%</td>
<td>27.9%</td>
</tr>
<tr>
<td>Hakura 2009</td>
<td>18.0%</td>
<td>15.8%</td>
<td>66.3%</td>
</tr>
<tr>
<td>Eastern Europe &amp; Central Asia</td>
<td>13.14%*</td>
<td>47.07%</td>
<td>39.78%</td>
</tr>
<tr>
<td></td>
<td>(.07)</td>
<td>(.05)</td>
<td></td>
</tr>
<tr>
<td>OECD</td>
<td>36.06%**</td>
<td>36.34%***</td>
<td>22.11%</td>
</tr>
<tr>
<td></td>
<td>(.01)</td>
<td>(.00)</td>
<td></td>
</tr>
<tr>
<td>Kose et al. 2003</td>
<td>36.6%</td>
<td>4.0%</td>
<td>43.7%</td>
</tr>
<tr>
<td>Hakura 2009</td>
<td>24.3%</td>
<td>21.7%</td>
<td>54.0%</td>
</tr>
<tr>
<td>Fernández et al. 2017</td>
<td>34.0%</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: The non-parametric regression is carried for all individual countries in the sample set, using the relevant regional and world factors as explanatory variables. Partial $R^2$ are computed for both regional and world factors. The variance decomposition values reported on table 2.6 are median values of these regressions. The levels of significance are reported with the following p-value legend: * 10% ** 5% ***≤1%

long-run volatility in this paper, compared to 20% in Hakura [2009]. Conversely, its contribution declines to 30% compared to a closer figure to the long run estimate of 15.8%. These results show indeed that nonparametric regression not only is more robust, but also reflects readily this region-specific event. This may indeed account for the large differences in country-specific shocks among the OECD countries, the 2007-2008 credit crunch crisis and the ensuing global downturn has had a significant impact on the global factor and its contribution in volatility among developed nations. It is also noting that while nonparametric estimation yields lower square errors, it can also have a tendency to over-smooth. We note however that robustness checks in the form of bandwidth significance tests, as well as the South Asia experiment with different time frame put this matter to rest. The fact that fluctuations in OECD are mainly driven by regional and global factors is partially confirmed by the literature: Kose et al. [2003] do mention that wealthier economies are well synchronised with international business cycles, and thus are more sensitive to global shocks. By contrast, they find that regional factors account for little in macroeconomic fluctuations, an assertion contradicted by this paper’s findings. Indeed, the median variance contribution for regional factors in the OECD is a little under 40%, which fits better with
the stylised facts described in the previous section, that is intra-region synchronisation is the
highest among OECD countries in comparison to the rest of the world. Each regional group for
EMEs displays a peculiar aspect: South Asia traces back almost half of its fluctuations from
regional factors, the highest among EMEs. This result can readily be explained by the impact
of the region-specific crisis of 1997-1998, and this shows in the comparison conducted for 1970-
1996. The Sub-Saharan Africa sample group displays the largest contribution of country-specific
shocks to fluctuations, followed by Latin America. MENA economies by contrast, are primarily
affected by global factors, which may be due to their reliance on commodities for export. The
significant differences among EME country groups as to the sources of fluctuations provide
further evidence the large magnitude of their fluctuations are due to external and domestic
shocks. Variance decomposition suggests that the heterogeneity of the stylised facts discussed
earlier can be accounted for by the differentiated impact of global, regional and country-specific
factors. As discussed before, findings displayed in table 2.4 contradict the literature’s: global
and regional factors dominate country-specific ones in shaping output fluctuations in emerging
economies. This paper argues these results are more robust on three levels: first, the array of
stylised facts described in the first section indicate emerging economies are more attuned to the
global cycle than the literature suggests. Second, the nonparametric estimation techniques used
in the next section do not constraint the data, and carry therefore little bias in comparison
to the parametric models favoured in the literature. Third, the nonparametric tests used to
check against over-explaining the data show the estimated results to be statistically significant.
This paper concludes therefore to the fact that external factors account for approximately 80%
of output fluctuations observed in emerging economies, a reversal of the domestic contribution
argued in the literature. Similarly, we find that OECD economies are also more sensitive to
external factors, including regional ones. These differences have a significant impact on how
policymakers should approach cycle-smoothing policies in emerging economies.

2.5 Conclusions

This paper contributes to the literature on business cycles in emerging economies. We investigate
the respective contributions of global and regional factors to the macroeconomic fluctuations
observed for these economies. On average, we find that global factors contribute approximately
for 40% of observed macroeconomic fluctuations, which is significantly higher than findings
in the literature. We therefore conclude that external factors affect EMEs almost as much
as developed economies. We concentrate in this section on the main policy implications of our
findings. Emerging economies stand to gain significantly more when business cycles are smoothed
or eliminated. Anderson and van Wincoop [2004] in particular prove that welfare gains from
cycle smoothing in Latin American economies can increase consumption per capita by 5 to
10%. These findings are significantly higher than those established for developed economies
in Reis [2009]. Furthermore, they develop a similar argument regarding emerging economies. In
addition to consumption per capita gains, they extend the definition of welfare gains to include
other macroeconomic variables as well. They show for instance that macroeconomic volatility
has a disproportionate effect on consumption per capita in various emerging economies, which
also means that excessive output fluctuations have an adverse effect on output growth per capita.
In light of these results, households in emerging economies can significantly improve
their consumption under cycle-smoothing policies, while the economy as a whole benefits from
increased output growth per capital as well. This paper has shown that external factors account
for a sizeable chunk of these fluctuations, in the form of de-trended output variance, which are

\[3\]

As mentioned earlier in the literature review section, there are substantial differences between our paper
and the quoted literature, in terms of country sample composition, time periods and econometric methods. We believe
however that comparison against the benchmark literature is nonetheless relevant, especially in the ranking factor
contributions to output variance.
beyond the reach of domestic policies. Lucas’s critique may apply when a poorly designed policy is implemented, and results in exacerbating fluctuations instead, thus inflicting a penalty on households, rather than increasing their lifetime consumption. *Illustrate the effects of such ill-designed policies, and posit that developing economies experience more domestic shocks due to self-inflicted policy mistakes. A promising research perspective would be to build a general equilibrium of a small open economy, with imperfect market structures and institutions.*
Bibliography


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Table 2.7: Sample set: individual countries and category groups.

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Chapter 3

A Steeper slope: the Laffer Tax Curve in Developing and Emerging Economies
A Steeper slope: the Laffer Tax Curve in Developing and Emerging Economies

Abstract

In comparing the tax burden between developed and developing economies, we argue that the Laffer curve is sensitive to two factors, namely the size of underground economic activities and tax collection costs. The baseline model exhibits counter-intuitive results for developing and emerging economies. Insofar as we find that they are able to extract higher tax rates and revenues in comparison with developed countries, the differences are due to the values computed for structural parameters and steady-state variables. However, when the share of underground activities is taken into account, the Laffer curve is pushed downward, while tax collection costs shift the peak rate to the left.

JEL Codes: H21, H26, H30, E32, E37.

The author thanks for their comments and remarks Jean-Pierre Allegret, Cécile Couharde, Lise Patureau, Fabien Tripier, Thepthida Sopraseuth and Ludovic Julien. Are also thanked participants at the 2017 IX SIGE workshop, Paris Nanterre University (November 2017) as well as the 2018 CEF Conference at Università Cattolica del Sacro Cuore, Milan (June 2018).

Cardinal Beaufort
The commons hast thou rack’d; the clergy’s bags
Are lank and lean with thy extortions.


Introduction

Even though it depicts an intuitive and well-documented relationship between tax rates and fiscal revenues, the Laffer tax curve remains a controversial concept in academic and policy-making circles. Contrary to spending, taxes are limited by the tax base from which revenues are extracted. Tax authorities can raise revenues by increasing taxes up to the point where a further increase yields no additional revenues, and may even lead to their decline. The Laffer curve effect laid out in Laffer [2004] states that when the tax rate goes past its peak, individuals had little incentive to work or produce additional output, which serves as the tax base.

The thrust of the debate in the 1980s focused on the issue whether tax rates in developed countries - mainly in Europe - have reached their peak on the Laffer curve, that is to say, the point where tax cuts could increase revenues. Most of the studies in this area follow the intuition later updated in Laffer [2004] by looking at the effects of changes in the marginal income (labour) tax rate on revenues and by implicitly assuming self-financed tax cuts. Laffer [2004] argues that losses from tax cuts generated by reductions in the marginal tax rate are more than
offset thanks to changes in income tax brackets that boost economic activities, and thus expand the tax base. Earlier studies were concerned with the level of taxation in developed countries - mainly in Northern Europe - and whether their respective tax rates lay beyond their peak rates. The implication is that these governments can increase revenues through tax cuts. Nevertheless, the literature has quickly restricted itself to study the effects of changes in the marginal income (labour) tax rate on revenues. The focus on labour taxes is mirrored in Prescott [2004], who argues that a substantial share of the discrepancy in worked hours between the United States and Europe can be accounted for by differences in labour tax rates. In his model, Prescott shows that income taxes in Europe are high enough to distort labour supply, and as a result GDP per worked hour is higher in the United States. The immediate conclusion is that an income tax cut in Europe would increase labour supply. Insofar as marginal changes of tax revenues are along the Laffer curve, no mention is made as to whether the tax cut is self-financed, that is, whether labour tax rates in Europe lie to the right of their Laffer curve peaks.

Governments in developing and emerging economies frequently engage in procyclical fiscal policies: they tend to cut taxes in booms, and raise them in recessions. This peculiar fiscal stance stems from the fact that running a budget surplus in booms is politically costly, thus the tax cuts during the expansionary phase of the cycle. By contrast, budget solvency, and subsequent fiscal consolidation measures needed to stanch high deficits exert further pressure to raise taxes in recessions. Furthermore, as noted by Talvi and Vegh [2005], because of the high variability in the tax base, governments in developing and emerging economies have no other option but to pursue procyclical fiscal policies. In addition, these policies exacerbate the business cycle in developing and emerging economies, which destablises further the base from which tax revenues are extracted. An additional feature of the Laffer curve in developing and emerging economies is the narrowness of their tax base. The literature frequently refers to the size of the underground economy as a factor that can explain inefficiencies in tax collection and difficulties in raising additional tax revenues. The inability of tax authorities in developing and emerging economies to raise more tax revenues means that they have access to a smaller tax base and lower peak tax rate as a result. Therefore, it can be argued that countries with a large sector of underground economic activities relative to GDP will exhibit a Laffer curve with a depressed shape, as well as a lower revenue-maximising tax rate. The same argument holds regarding the size of agriculture in the economy, which also implies an elusive tax base. In developing and emerging countries, a shrinking tax base places a disproportionate burden on economic activities that are subject to taxation, which in turn depresses the elasticity to the tax rate. The shrinking tax base tends to push the Laffer curve downwards and shifts it to the left, which corresponds to lower tax revenues for a given tax rate, and a lower revenue-maximising tax rate. As a result, governments in developing and emerging economies would improve their tax revenues by reducing the size of underground economic activities relative to GDP. By incorporating a large share of their tax base for assessment, tax authorities can increase their revenues at constant rate.

In this chapter/paper we rely on the framework with which Trabandt and Uhlig [2011, 2012] came up in order to develop a Laffer tax curve specific to developing and emerging economies. We focus on the two main features of these countries, namely the large share of underground economic activities in output, and the collection cost tax authorities face. This allows us to highlight differences in Laffer curve shapes and peak rates between these countries and developed economies. We argue that tax authorities in developing and emerging economies face two broad challenges in implementing their fiscal policy, namely the importance of underground and/or undeclared economic activities relative to GDP, as well as high tax collection costs. Both factors result in either a shrinking tax base, or a variable tax base that prevent governments in these countries from extracting higher tax revenues. We summarise in this paper the differences between the two category groups of countries as follows: first, the Laffer curve is flatter and skewed to the left among developing and emerging economies with respect to developed ones.
Second, the former reach a lower peak rate, which translates into lower tax revenues in comparison with the latter. We explain these discrepancies by showing that a large untaxed/undeclared underground sector depresses tax revenues, while high collection costs shift the Laffer curve to the left.

The chapter/paper is outlined as follows: the first section provides a review of the literature that focuses on two central aspects of fiscal policy. First, we address the debate in the literature as to how elastic the bases are to tax changes. In particular, we discuss the literature’s predictions on household’s labour supply elasticity. We also look at how the literature identifies and addresses the challenges encountered by tax authorities in developing and emerging countries. The second section introduces the model and its extensions. It presents the baseline model which is an alteration of the Trabandt-Uhlig framework. The baseline model is then upgraded with additional components that take into account the existence of undeclared/untaxed economic activities, as well as a quadratic cost of tax collection. The third section introduces the dataset, its sources and the treatment it goes through as a prelude to model simulation. We calibrate numerical values for structural parameters in our model, then estimate them using the Simulated Method of Moments. We compare estimated results against the usual values adopted in the literature for developed countries, and, to a lesser extent, developing ones. The fourth section reports the Laffer tax curves derived from the simulations of our model. We do observe that Laffer curves are flatter and steeper to the right of their peak rates in emerging countries, with lower tax rates and revenues compared to developed countries. The shift to the left is attributed to tax collection costs, whereas the depressed shape is explained by the existence of undeclared/untaxed economic activities. The section also presents and discusses predictions on the size of tax cuts in consumption, labour and capital that are self-financed. It focuses on the differences of self-financing for each component of the tax base, as well as the varying efficacy of such a policy under the baseline model and its two extensions. The fifth and last section concludes.

3.1 Literature review

We review in this section bodies of the literature that relate to the main contributions of this paper. We underline the main conclusions that the literature derives regarding the distortionary effects of taxes. We also look at the main conclusions derived by the literature regarding taxation and its issues in developing and emerging economies. The seminal contributions of Mirrlees [1971], Diamond and Mirrlees [1971] and Atkinson and Stiglitz [1976] have set the theory of optimal taxation in a rigorous analytical framework. The common thread in this pioneering literature is the importance of agent behaviour and how it considered in government policies. They stress what is a cornerstone of the Lucas [1972] critique, namely that fiscal policy needs to take into account individual economic agents’ response to policy changes. Mirrlees [1971] offers an analytical framework where distribution of skill and human capital among the population affects progressive taxation. He also stresses the importance of the consumption/leisure tradeoff in determining labour supply. This paper concerns itself with the amount of fiscal revenues the government can raise through consumption, labour and capital taxes. As such, we are not interested in welfare effects that stem from redistributive taxation, as it is the case in Mirrlees [1971] or Atkinson and Stiglitz [1976].

Atkinson and Stiglitz [1976] discuss the distortionary effects of taxation in a world of heterogenous economic agents. There are also screening and agency issues the authors discuss, which are not relevant to the topic at hand.
Distortionary effects of taxation - labour supply

A more recent body of literature studied the specific distortions of taxation on labour supply. Prescott [2004] studies the determinants of the gap in worked hours between the United States and a set of European countries. He uses a general equilibrium model in order to isolate the wedge effect generated by labour and consumption taxes on household labour supply. Prescott offers predicted volumes of worked hours that fit well with actual levels in Europe and the United States. Using the tax wedge and consumption-to-output ratio at the steady-state, the author concludes that workers in Europe work fewer hours than their American counterparts because the tax wedge is larger due to higher taxes in Europe. Rogerson [2006] agrees that government dynamics - as well as technology- are a prime candidate to account for the gap in worked hours between Europe and the United States. He mentions however that way the government spends its revenues influences the household labour supply schedule. Rogerson identifies two particular cases where labour supply is sensitive to taxation. First, when the government uses tax revenues to fund a lump-sum transfer, it creates an income effect which influences the household labour supply schedule. Second, if the government subsidises leisure instead, there is a substitution effect which alters the household labour supply schedule. The substitution effect is discussed by Langot and Lemoine [2017] in their discussion of shifting the tax burden to consumption and away from leisure. They conclude that coordinated fiscal policy can overcome labour market weaknesses brought about by a large tax wedge. Rojas Quintero and Langot [2016] provide an alternative specification to the labour market in order to assess the impact of the tax wedge on labour supply. Using a search & match model à la Mortensen and Pissarides [1994], the authors show that they are able to better assess the time-varying impact of taxation on the labour market. Rojas Quintero and Langot [2016] are able to mimic the dynamics of worked hours - the intensive margin- as well as labour force participation - the extensive margin-in ten OECD countries between 1980 and 2013. Finally, the aftermath of the 2008 financial crisis and the inability of governments in developed economies to use fiscal instruments to mitigate its economic impact prompted a debate in Trabandt and Uhlig [2011, 2012] and Alesina and Giavazzi [2013] to re-assess the Laffer effects of the aggregate fiscal burden.

The household labour supply elasticity conditions the size of distortions generated by the tax wedge on the substitution effect. The literature defines the Constant Frisch Elasticity (CFE) of labour to wages at constant wealth. It measures the sensitiveness of labour supply to exogenous shocks, such as changes in the tax rate. There is a great deal of debate as to the range of acceptable values it takes. Raj Chetty et al. [2013] review results from micro- and macro-based pieces of evidence collected for developed economies. Their compendium highlights the contradictory results put forward in the literature with respect to household labour supply elasticity. Micro-based estimates rely on household surveys, and increasingly on field and natural experiments in order to give CFE parameter estimates. Chetty [2012] estimates the Frisch elasticity to be around 0.25 for micro-based studies. By contrast, macroeconomic datasets yield a higher estimate for the CFE parameter, ranging from 0.39 in Davis, Steven J. and Henrekson, Magnus [2005] and values as high as Prescott [2004] at 1.18. On average, macro-based evidence yields a comparatively higher value of 0.71.

Differences in CFE values among developed economies lead to different interpretations of the importance of extensive and intensive margins. A high value for the Frisch elasticity assumes that the household is quite responsive to changes in labour income, at constant wealth level. In particular, the household is more willing to adjust worked hours, which is why we observe that macroeconomic aggregate to be highly procyclical. Raj Chetty et al. [2013] report that as a result, macro-based evidence tends to assign higher values to the CFE parameter in comparison to microeconometric studies. Macroeconomic models mitigate the effects of the discrepancy by introducing indivisible labour à la Hansen [1985] - namely, they take into account the extensive margin of labour supply. In this case, the procyclicality of worked hours is tempered with

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much slower dynamics of entrances and exits on the labour market.

The importance of the intensive margin justifies the use of a non-separable utility function in order to describe the dynamics of household decision-making. Under the assumption of non-separability, the Frisch elasticity incorporates both the cross-elasticity of consumption and labour, as well as the intensive margin of the latter itself. Microeconometric evidence from the United States, and supplied by Hall [2009] offers empirical justification to adopt non-separability in the household’s utility function. Nevertheless, it is difficult to prove the importance of intensive margins in developing and emerging economies. The literature on field experiments in those economies suggests that cash payments have little effect on working hours for targeted households. Studies from Latin America suggest that while the welfare effects of targeted subsidies are tangible and significant, there are no noticeable or significant changes in worked hours among households. Bloom et al. [2009] find that there is an increase in labour supply among women who improve their income thanks to these cash transfers. The change in labour outcome is however observed mainly in terms of new arrivals on the labour market, and not in changes in worked hours. Alzua et al. [2010] study the conditional cash transfer programmes enacted in Mexico, Nicaragua and Honduras, and conclude that these programmes do not provide significant disincentives to work. In particular, the targeted households do not exhibit significant changes in worked hours, whereas tremendous changes are reported for child labour, which is halved, and increasing labour participation of female members of these households. In Brasil, Veras Soares et al. [2007] find similar results, with no sizeable impact on worked hours as well as labour force participation. Ardington et al. [2009] study the impact of a social transfer scheme in South Africa, in the form of increased pensions for retirees. They find that households with at least one pensioner exhibit an increase in employment rates, but no changes in worked hours. These findings suggest that the intensive margin is small to nil in developing and emerging economies. By contrast, the extensive margin effects are large and significant, especially for female members of the workforce.

The cash transfer programmes in Latin America, and pension reforms in South Africa elicit changes in labour supply that can be used as proxies for income shocks. Given the randomness of instruments used by each of these studies, Frisch elasticity estimates can be inferred from changes in labour supply. Given the lack of statistically significant results for the intensive margin, it stands to reason to conclude that these are not as important in developing and emerging economies as they are in developed ones. As a result, we can rule out the importance of cross-elasticity between worked hours and household consumption, and focus instead on the extensive margin. In addition to the preeminence of labour enrolment over worked hours, developing and emerging economies exhibit also specific features regarding the way fiscal policy is carried out, and how tax dynamics play out.

Taxation in developing and emerging economies

There is a host of issues that can account for differences of shape of tax revenues raised by the Laffer curve between developed and developing and emerging economies. The literature frequently refers to the size of the underground economy as a factor that can account for inefficiencies in tax collection and raised tax revenues. Feld and Schneider [2010] underline the importance of underground economic activities relative to GDP. They point out that these are higher among developing and emerging economies in comparison to developed countries. As a result, the tax base is narrower, and results in significant tax revenue losses. The inability of tax authorities in developing and emerging economies to raise more tax revenues means that they have to contend with a smaller tax base and a lower peak rate as a result. The same argument can be made with respect to the size of agriculture in the economy, which also leads to an unreliable tax base. Khan [2001] reports that for a sample of developing and emerging countries, the steady growth in agricultural GDP has not generated a commensurate increase in fiscal rev-
enues. He ascribes this result to the difficulties tax authorities encounter in those economies in assessing agricultural income for taxation. In addition, tax authorities in developing and emerging countries may face significant costs in tax collection. Fiscal inefficiencies are underlined in Agénor and Montiel [2015]. They argue that the government faces a continuum of small-income earners that represent a disproportionately large share of potential taxpayers. Tax authorities therefore face an inadequate tax base, one where revenues cannot be extracted without incurring substantial collection costs. Furthermore, mediocre institutional quality in those countries implies a potential for corruption that further erodes fiscal efficiency. The political economy of taxation and fiscal policy is also highlighted by Cukierman et al. [1992]. These authors show that tax efficiency is positively correlated with political stability and institutional quality, as well as other economic indicators, such as the sector composition of output, urbanisation and openness to trade. Stern [1991] also studies taxation in developing and emerging economies through the prism of their political economy. This has been mentioned by Buchanan and Lee [1982] when they argue that the government sets its short-run tax rate beyond its long-run peak value due to electoral considerations. The fact that governments in developing and emerging economies may have endogenous preferences in forming their policies may have a significant impact on fiscal policy design. This is critical to these economies, since the government frequently steps in to supply public goods, or implement transfer schemes to support its population. As a result, fiscal policy is key, either through taxes as a source of revenues, or through tax incentives that respond to a welfare criterion. The fact the policymakers may have endogenous preferences may skew fiscal policy instruments, and introduce distortions in addition to those of the tax wedge itself.

### 3.2 The model

The benchmark setup for our model reprises Trabandt and Uhlig [2011, 2012] where the inter-temporal optimisation programmes of firms and households reflect the distortionary effects of taxation. Households maximise their lifetime utility function subject to resources constraint. The programme writes:

$$\max_{c,n,k,i,b} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t [u(c_t, n_t) + v(g_t)]$$  (3.2.1)

subject to:

$$(1 + \tau^c_t)c_t + i_t + b_t \leq (1 - \tau^n_t)w_t n_t + (1 - \tau^K_t)(r_t - \delta)k_{t-1} + \delta k_{t-1} + R^b_t b_{t-1} + s_t$$  (3.2.2)

$$k_t = (1 - \delta)k_{t-1} + i_t$$  (3.2.3)

Where $c, n, g$ denote respectively consumption, labour and government expenditure. Capital law of motion (3.2.3) states that future capital $k$ is equal to its present value net of depreciation factor $\delta$ plus investment $i$. Notice that the government levies taxes on consumption, labour and capital to fund its expenditure. They also issue a state-contingent one-period bond $b$ with coupon $R^b$. The government budget constraint writes:

$$g_t + s_t + R^b_t b_{t-1} \leq \tau_t + b_t$$  (3.2.4)

$$\tau_t = \tau^c_t c_t + \tau^n_t w_t n_t + \tau^K_t (r_t - \delta)k_{t+1}$$  (3.2.5)

Where $\tau$ refers to tax revenues from consumption, labour and capital, denoted $\tau^c, \tau^n$ and $\tau^K$ respectively. The government spends $g$ and transfers $s$ to households, while it pays $R^b$ in debt and coupon. Firms maximise their profits subject to technology, denoted $z$ and output $y$. Their maximisation programme writes:

$$\max_{k,n} y_t - r_t k_{t-1} - w_t n_t$$  (3.2.6)

subject to:

$$y_t = z_t k_{t-1}^{\alpha} n_t^{1-\alpha}$$  (3.2.7)
Constant Frisch elasticity - labour supply wedge

As noted in [Rogerson 2006] and [Prescott 2004] among others, the standard optimality condition for labour supply for the household implies that the marginal rate of substitution between consumption and labour is equal to the marginal productivity of the latter. Formally:

\[ |MRS_c^n| = MPL \]  

(3.2.8)

In a model with taxes on consumption and labour however, taxes have a distortionary effect on equation (3.2.8). The tax wedge, which we denote \( \varphi(\tau) \leq 1 \) can be computed from the household optimisation programme in equations (3.2.1) through (3.2.3). The optimality condition is thus:

\[ \frac{\partial U_n}{\partial U_c} = \frac{1 - \tau^n}{1 + \tau^c} \times w \]  

(3.2.9)

Where \( w = \frac{\partial y}{\partial n} \) and \( \partial U_x \) denotes the marginal utility with respect to argument \( x \), with \( x \in c, n \).

We also write \( \varphi(\tau) = \frac{1 - \tau^n}{1 + \tau^c} \) for the tax wedge, and \( w \) wages, which are equated with marginal productivity of labour. Equation (3.2.8) can be rewritten as follows:

\[ |MRS_t^{c,n}| = \varphi(\tau_t)MPL_t \]  

(3.2.10)

As mentioned before, we make a departure from the benchmark model laid out by Trabandt & Uhlig by assuming separability of consumption and labour in the household’s utility function. We propose the following functional form to incorporate in equation (3.2.1):

\[ u(c_t, n_t) = c_t^{1-\sigma} / (1-\sigma) - \frac{n_t^{1+\phi}}{1+\phi} \]  

(3.2.11)

Where \( \sigma \geq 1 \) denotes the Constant Relative Risk Aversion (CRRA) elasticity of substitution parameter, and \( \phi \geq 0 \) the inverse Constant Frisch Elasticity (CFE) of labour supply to wages. Equation (3.2.10) can therefore be rewritten as follows:

\[ n_t^{\phi} c_t^{\sigma} = \frac{1 - \tau^n_t}{1 + \tau^c_t} \times \frac{(1 - \alpha)y_t}{n_t} \]  

(3.2.12)

We rewrite equation (3.2.12) in order to provide a tractable expression of after-tax labour supply, which we denote \( n_t^*(\tau) \):

\[ n_t^*(\tau) = \left[ (1 - \alpha)y_t c_t^{-\sigma} \varphi(\tau_t) \right]^{1/(1+\phi)} \]  

(3.2.13)

Equation (3.2.13) depends on We can show that after-tax labour supply decreases with the size of the tax wedge, meaning that the larger consumption and labour taxes, the smaller \( \varphi(\tau) \) gets, and the higher its distortionary effects on the optimality condition of equation (3.2.9). We can also show that the elasticity of labour supply to the tax wedge is the inverse of \( 1 + \phi \). Although our specification differs from that of Trabandt & Uhlig, we also find that labour supply can be written as a function of its share of output, \( 1 - \alpha \), the tax wedge, \( \varphi(\tau) \) and the Frisch constant elasticity, \( \phi \). However, our expression is more parsimonious.

The capital tax wedge

In addition to labour and consumption taxes, the government also taxes capital, which introduces a wedge between its marginal productivity and the rent it pays to capital-holders. Namely:

\[ r_t = (1 - \tau_t^k)(\alpha y_t / k_{t-1} - \delta) \]  

(3.2.14)

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At the steady-state, the after-tax capital-to-output ratio is:

$$\frac{\bar{k}}{y} = \left[ \frac{\bar{r}}{\alpha(1 - \tau^k)} + \frac{\delta}{\alpha} \right]^{-1}$$

(3.2.15)

We observe that the after-tax capital-to-output ratio declines with capital tax $\tau^k$. Since capital stock declines with taxes, its marginal productivity increases as it becomes scarce, and thus rent $\bar{r}$ increases. We argue that the capital-to-output ratio does not give a meaningful idea of the capital tax base and the distortionary effect beyond that on rent $\bar{r}$. Instead, we use the Euler equation from the household’s optimisation programme in order to extract an expression for the steady-state after-tax capital stock as a function of its tax $\tau^k$ as well as other variables and parameters of interest. We write the full Euler equation as delineated in equations (3.2.1) to (3.2.3):

$$c - \sigma \left[ \frac{c_{t+1}^{\sigma}}{1 + \tau_{t+1}} \right] = \beta E \left[ c_{t+1} - \sigma + 1 \right] \left[ 1 + (1 - \tau_{t+1}) \left( \alpha z_{t+1} n_{t+1}^{1-\alpha} k_{t+1}^{\alpha-1} - \delta \right) \right]$$

(3.2.16)

At the steady state, equation (3.2.16) is rewritten so as to provide an expression for the after-tax capital stock, which writes as follows:

$$\bar{k}(\tau^k) = n \left[ \frac{\alpha \beta \bar{z}(1 - \tau^k)}{1 - \beta + \beta \delta(1 - \tau^k)} \right]^{1/(1-\alpha)}$$

(3.2.17)

Balanced growth at the steady-state implies that both capital and labour increase at similar rates. As shown in equation (3.2.13) after-tax capital stock is also influenced by levels of taxes on labour and consumption. It is also increasing in productivity as measured by steady-state TFP growth rate $\bar{z}$. High values of $\beta$, the discount factor, denote low interest rates, and therefore high capital stock. Parameter $\alpha$ has also a positive impact on capital stock, since a high value means that capital captures a larger share of output. Finally, capital stock is decreasing in depreciation factor $\delta$ and the tax rate $\tau^k$.

Extensions of the Laffer baseline model

The baseline model described in the section above uses a neoclassical setting in order to build a micro-founded Laffer curve. Nonetheless, the model does not make provisions for cases where the government is unable to extract full revenues from its tax bases, or faces collection costs. For instance, the neoclassical model suggests that labour supply shifts entirely to leisure (or non-market activities) when it is taxed at 100%. Such an extreme case does not take into account the possibility that some residual share of household labour supply remains untaxed. This would be the case either because the government cannot tax it, or would bear prohibitive costs in doing so. The extensions to the baseline model explore two ways to account for imperfect governance in the Laffer curve. The first is to assume that resources are only partially subjected to taxation. The second posits that tax authorities lose a fraction of their fiscal revenues when they are collected.

The benchmark model with untaxed/undeclared tax base

The core components of the baseline are kept in place. We now assume that only a fraction $p \in [0; 1]$ of the tax base is available for the government to extract fiscal revenues. The rationale behind this model is that underground economic activities exist regardless of current levels of taxation. We argue that factors other than taxation may have an impact on the size of the underground economy relative to GDP. Feige and McGee [1983] argue that the Swedish tax system is too onerous and provides incentives for economic agents to evade taxes through undeclared economic activities. As far as developing and emerging economies go, that may well...
be also true in their case, though it is not realistic to assume that the underground economy is all about tax evasion. A large shadow economy relative to output could also be the sign of an unhealthy relationship between citizens in a given country, and their government. Per Frey and Schneider [2000] and Schneider et al. [2010], lack of confidence in government institutions may lead agents to hide their resources away from tax authorities. In addition, developing and emerging economies exhibit a higher share of undeclared economic activities relative to GDP either because the dominant sectors are difficult to assess for taxation, or because the government needs to exert costly efforts to assess its tax base. Agriculture is a pertinent example to illustrate the ambiguity of underground economic activities and the difficulties surrounding their tax assessment. We propose to model the share of taxable economic activities as a probability $\rho$ that an individual economic agent pays taxes on consumption, labour and capital stock. As a result, economic agents adapt their optimisation programme in order to reflect both effects of differentiated taxation and its distortions on their choices. Household optimisation seeks to maximise lifetime utility in equation (3.2.1) on consumption and labour, subject to the new resources constraints below:

$$c_t(\rho(1+\tau_t^n)+(1-\rho)) + i_t + b_t - w_t n_t (\rho(1-\tau_t^n) + (1-\rho)) - (1-\delta)(\rho(1-\tau_t^n) + (1-\rho)) - R_t b_t - 1$$  (3.2.18)

The optimisation programme for the household reflects the impact of untaxed/undeclared economic activities. First order conditions for consumption and labour yield the optimality condition which equates the household marginal rate of substitution with marginal productivity of labour, namely:

$$c_t^s n_t^s = \frac{1 - \rho + \rho(1 - \tau_t^n)}{1 - \rho + \rho(1 + \tau_t^n)} w_t$$  (3.2.19)

The wedge in equation (3.2.19) is denoted $\varphi(\tau, p)$ such that $\varphi(\tau, p) \geq \varphi(\tau)$ the tax wedge derived for equation (3.2.9). The government’s inability to extract taxes from the full labour tax base results in smaller distortion effects. This means that a government that can only tax a share $\rho$ of its tax base generates fewer distortions. Indeed, the neoclassical setting of our model predicts that fraction, $1 - \rho$, of underground/undeclared labour behaves according to the optimality conditions set out in equation (3.2.8). As a result, the overall distortionary effect of taxation is mitigated. The tax wedge takes into account tax rates for labour and consumption, as well as the share $\rho$ of taxed/declared activities. The steady-state expression for after-tax labour supply, denoted $n^s(\tau, p)$, writes:

$$n^s(\rho, \tau) = \left[ (1 - \alpha)c^{1 - \rho + \rho(1 - \tau^n)} y^{1 - \rho + \rho(1 + \tau^n)} \right]^{1/(1+\delta)}$$  (3.2.20)

Equation (3.2.20) shows that the distortion effect is lower in the after-tax labour supply than in the benchmark expression of equation (3.2.13). By contrast, the labour Laffer tax curve will also be constrained by the fraction $\rho$ of taxed wages. As a result, the effective tax base is now $\tau^n \rho w n$, implying a narrower labour tax base for any rate $\tau^n$. The labour Laffer tax curve will be therefore flatter than the one predicted in the baseline model.

We proceed with the same steps in writing the after-tax capital stock. We rewrite the Euler equation (3.2.16) in order to incorporate shares $\rho$ and $1 - \rho$ of taxable and undeclared marginal returns of capital, as well as consumption. We obtain the following expression:

$$\frac{c_t^s c_{t+1}^{\sigma}}{1 - \rho + \rho(1 + \tau_t^n)} = \beta E \left[ \frac{c_{t+1}^{\sigma}(1 - \rho + \rho(1 - \tau_{t+1}^k))}{1 - \rho + \rho(1 + \tau_{t+1}^n)} \left( 1 + \alpha z_{t+1} n_{t+1}^{1 - \alpha} k_t^{\alpha - 1} - \delta \right) \right]$$  (3.2.21)
Note that the Euler equation takes into account not only present and future tax rates for consumption and capital, but also the distortionary effect of partial access to tax bases. The same interpretation as for equation (3.2.20) applies. The expression of after-tax capital stock can be written as follows:

\[ k(\rho, \tau) = n(\rho) \left[ \frac{\alpha \beta \bar{z}(1 - \rho + \rho(1 - \tau))}{1 - \beta + \beta \delta (1 - \rho + \rho(1 - \tau))} \right]^{1/(1-\alpha)} \] (3.2.22)

The distortionary effects of taxation on after-tax capital stock are increasing in the size of declared/taxed share \( \rho \). When \( \rho \) converges to unity, steady-state capital stock described in equation 3.2.22 converges to its baseline expression (equation (3.2.17)).

The benchmark model with collection costs

In collecting its tax revenues, the government loses a fraction of it, either in the form of bureaucratic processing costs, or because of inherent inefficiencies. We use the quadratic form for the collection cost to incorporate in the budget constraint. Equation 3.2.23 allows us to introduce tax revenue losses with each tax rate change in the model. Parameter \( \kappa \) captures the amount of marginal revenue loss as the ratio between actual tax burden and the theoretical contribution of each tax rate to total fiscal revenues.

\[ g_t + s_t + b_t - \tau_t b_{t-1} \leq \tau_t + b_t - \frac{\kappa}{2} \tau_t^2 \] (3.2.23)

\[ \tau_t = r_t c_t + \tau_t^n w_t n_t + \tau_t^k (r_t - \delta) k_{t-1} \] (3.2.24)

Recall that \( \tau \) is total fiscal revenues. When expressed as a percentage of output, it becomes aggregate tax burden \( \tau/y \). For every marginal change in the overall tax burden, the government loses a fraction \( \kappa \), hence the quadratic component \( 0.5 \kappa \tau^2 \). The collection cost encompasses various inefficiencies, ranging from high effort the government needs to exert to extract taxes, to inefficient loopholes in domestic legislation. Given that the quadratic cost is not included in the household’s optimisation programme, enters in the Laffer curve on the revenue side as a result of government tax policy. As a result, the government no longer sets a tax rate \( \tau \) for each component of its tax base. Instead, we replace each tax rate of the baseline model by a new rate denoted \( \tau^\kappa \) such that \( \tau^\kappa = \tau (1 + \kappa \tau/2) \). Instead of taxing at rate \( \tau \) the government taxes at \( \tau^\kappa \) with \( \tau^\kappa \geq \tau \). The collection cost implies a loss of fiscal revenues proportional to the tax rate. Due to their budget constraint, tax authorities increase their tax rate by the same amount. As a result, the Laffer curve becomes more sensitive to tax rate changes: The baseline model predicts \( \partial \tau \), while the extension model implies \( \partial \tau^\kappa = (1 + \kappa) \partial \tau \). This collection cost results not only in higher effective tax rates, it also accelerates the convergence to the peak rate, which generates a reduction in the amount of tax revenues the government can collect. Changes in the tax rate become more expensive as tax authorities need to offset tax collection costs. Consequently, the economy reaches more rapidly its peak rate, which implies a shift of the Laffer curve to the left. Furthermore, as the distortionary effects become larger, the tax base narrows, and tax revenues associated with the peak rate decline.

Shapes of the Laffer tax curve

We have defined in the previous section the after-tax expressions of labour supply and capital stock, as well as the distortionary effects of taxation. We are now able to formulate expressions for the labour and capital Laffer tax curves, denoted respectively \( \mathfrak{L}(n, \tau^\kappa) \) and \( \mathfrak{L}(k, \tau^\kappa) \). For each factor of production, we multiply its tax base \( x \) by its tax rate \( \tau^\kappa \) to get tax revenues \( \mathfrak{L}(x, \tau^\kappa) \) such that \( \mathfrak{L}(x, \tau^\kappa) = \tau^\kappa x \). Marginal returns from the tax base are computed as follows:

\[ \frac{\mathfrak{L}(x, \tau^\kappa)}{\partial x} \]
whereas the marginal tax revenues for the government are written as follows: \( L(x, \tau) \frac{\partial \tau}{\partial x} \). The Laffer curve for each tax base exhibits a non-monotonic: tax revenues are concave and increasing in the tax rate until the latter reaches its peak value. Beyond this point, tax revenues decline until they reach zero.

The curve, its peak rate and revenues are all function of structural parameters. For labour supply, the literature has discussed exhaustively the impact of the tax wedge \( \varphi(\tau) \) as well as the size elasticity of substitution. By contrast, it has devoted little time to study the impact of other structural parameters and steady-state variables. Other components can also influence the Laffer curve and its shape: for instance, the consumption-to-output ratio, which measures the income effect, may dominate the substitution effect (CFE parameter \( \phi \)). Labour share of output, \( 1 - \alpha \), also contributes to the income effect in determining labour’s share of total output. Similarly, other factors can influence the capital Laffer tax curve. After-tax capital stock is increasing in labour, as well as the steady-state productivity growth rate (\( \bar{z} \)). The capital tax Laffer curve is also sensitive to interest rate net of depreciation (\( \bar{r} - \delta \)), the discount factor, \( \beta \), and the capital share of output \( \alpha \).

### 3.3 Data and descriptive statistics

#### Data sources

We use data from available open sources and seek to build the largest set possible of countries to incorporate in our sample set. To that effect, we use the [World Bank 2018](https://data.worldbank.org) World Development Indicators (WDI), the Groningen Growth & Development Center database in [Feenstra et al. 2015](https://www.pwt7.org) (formerly the Penn World Table - PWT) and KPMG consultancy firm database of corporate tax rates. These three sources allow us to calibrate and estimate the structural parameters of the model in this paper. These datasets also allow us to compute the effective tax rates that match these of our model. [Mendoza et al. 1994](https://www.nber.org/macrobb/) point out that official tax rates do not form a pertinent basis for cross-country comparison due to the plethora of differences in domestic legislation, tax collection enforcement and allowances for tax deductions. As a result, they propose to compute effective tax rates using common tax bases. Fortunately, the WDI dataset has already harmonised to a large degree cross-country tax rates, although we still need to introduce some alterations following the methodology of [Mendoza et al. 1994](https://www.nber.org/macrobb/). The discrepancies between advertised and effective tax rates are well illustrated with the tax rates compiled by KPMG for a fairly large country sample set. Using the Laffer capital tax curve, we investigate whether the corporate tax rate lies beyond its peak rate value for instance. Finally, we also use [Schneider et al. 2010](https://www.kpmg.com) and their measure of the underground economy in GDP for a large set of countries to compute the share of undeclared and untaxed economic activities in GDP.

Table 3.1 below reports the main macroeconomic variables used for our calibration/estimation exercise. The table also reports the relevant data sources and references, as well as transformations introduced to achieve this objective. Real GDP extracted from the WDI dataset is used as a proxy for output in our model. GDP is expressed in real Dollars for adequate cross-country comparisons. Other macroeconomic aggregates, such as household expenditure and gross capital formation are used as stand-ins for consumption and investment, respectively. We prefer to extract these variables in terms of fractions of GDP from the PWT dataset for two reasons: first, they provide adequate time series in order to compute steady-state values for our model. Second, we can avoid national accounting discrepancies when both variables are incorporated in real Dollars instead. We also use data on capital stock in order to calibrate values for capital share of output \( \alpha \) and depreciation factor \( \delta \). Capital stock is also expressed in real Dollars for

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cross-country comparisons. Productivity, defined as Total Productivity Factors (TFP), is measured as relative TFP to the United States in the PWT database. Given that the literature has formed a broad consensus on an annual 2% for the long-run TFP growth in the United States, TFP growth rates for each country is computed as the product of its relative productivity and 1.02 (1+2%). As mentioned earlier, we have argued for incorporating labour in the model as an enrolment rate rather than a share of worked hours. As a result, we look for data on the share of employed individuals in the 15-64 age cohort for each country. Interest rate is computed from lending interest rate adjusted for inflation. Individual values for countries may differ wildly because many developing and emerging economies have experienced episodes of hyperinflation in the past. As a result, we expect structural parameters that are calibrated out of this variable to exhibit significant cross-country differences. Finally, taxes are kept unchanged except the variable for labour taxes and contributions. We multiply this variable by $\frac{\alpha}{1-\alpha}$ in order to substitute the denominator (profits and revenues) with wages. The dataset we have built from these macroeconomic variables reported in table 3.1 is then used for assigning numerical values to our structural parameters, first by means of calibration, and then with estimation techniques. The dataset also provides long-run averages for steady-state values of our model’s variables.

Table 3.1: Core macroeconomic variables used for calibration/estimation of structural parameters.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Set</th>
<th>Reference</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output $y$</td>
<td>WDI</td>
<td>NY.GDP.MKTP.KD</td>
<td>GDP (constant 2010 US$)</td>
</tr>
<tr>
<td>Consumption $c$</td>
<td>WDI</td>
<td>NE.CON.PETC.ZS</td>
<td>Household final consumption expenditure, etc. (% of GDP)</td>
</tr>
<tr>
<td>Capital $k$</td>
<td>PWT</td>
<td>CK</td>
<td>Capital stock at current PPPs (in mil. 2011US$)</td>
</tr>
<tr>
<td>Investment $i$</td>
<td>WDI</td>
<td>NE.GDI.TOTL.ZS</td>
<td>Gross capital formation (% of GDP)</td>
</tr>
<tr>
<td>Productivity $z$</td>
<td>PWT</td>
<td>CTFP</td>
<td>TFP level at current PPPs (USA=1)</td>
</tr>
<tr>
<td>Labour $n$</td>
<td>WDI</td>
<td>SL.TLF.CACT.ZS</td>
<td>Labour force participation rate (ILO estimate)</td>
</tr>
<tr>
<td>Interest rate $\tau$</td>
<td>WDI</td>
<td>FR.INR.RINR</td>
<td>Real Interest rate</td>
</tr>
<tr>
<td>Tax burden $\tau^c$</td>
<td>WDI</td>
<td>GC.TAX.TOTL.GD.ZS</td>
<td>Tax revenue (% of GDP)</td>
</tr>
<tr>
<td>Cons. tax $\tau^c$</td>
<td>WDI</td>
<td>GC.TAX.GSRV.VA.ZS</td>
<td>Taxes on goods and services (% value added of industry and services)</td>
</tr>
<tr>
<td>Capital tax $\tau^k$</td>
<td>WDI</td>
<td>GC.TAX.YPKG.RV.ZS</td>
<td>Taxes on income, profits and capital gains (% of revenue)</td>
</tr>
<tr>
<td>Labour tax $\tau^n$</td>
<td>WDI</td>
<td>IC.TAX.LABR.CP.ZS</td>
<td>Labour tax and contributions (% of commercial profits)</td>
</tr>
</tbody>
</table>

Note: Data for all sources spans 1950-2015. We use long-run average on available data points for each country in our sample set.

Calibration

Given the sample size of our country group, as well as the constraints on data availability across our data sources, we opt for a streamlined process in assigning numerical values to our parame-
ters. To that effect, we follow the advice given by Kydland and Prescott [1998] where discipline should be exercised as to the calibration strategy of the model’s deep structural parameters. For instance, we expect significant differences in parameter values, even among seemingly homogenous country groups. By contrast, the literature opts for a unique set of calibrated values, as is the case in Trabandt and Uhlig [2011, 2012]. The authors calibrate similar values for EU-14 countries and the United States, even though small but significant differences subsist between the two sets of calibrated values. That is why, in contrast to this avenue, we calibrate specific values for each country in our sample set, following Kydland and Prescott [1998] and Cooley [1995]. Namely, we compute long-run averages and ratios for the relevant macroeconomic aggregates and time series, and extract calibrated values for our structural parameters. We show that for some of these, the Laffer curve is quite sensitive and alter its shape significantly from one country to another. Table 3.2 below reports the structural parameters for our model, their respective economic interpretations, as well as the support range of acceptable values and calibration formulas.

Table 3.2: Structural parameters - benchmark and extension models.

<table>
<thead>
<tr>
<th>Par.</th>
<th>Interpretation</th>
<th>Support</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>Capital share</td>
<td>$]0; 1[\ln \bar{y} - \ln \bar{n}$</td>
<td>$\ln \bar{k} - \ln \bar{n}$</td>
</tr>
<tr>
<td>$\beta$</td>
<td>Discount factor</td>
<td>$&lt; 1$</td>
<td>$1/(1 + \hat{\gamma})$</td>
</tr>
<tr>
<td>$\delta$</td>
<td>Capital depreciation</td>
<td>$]0; 1[\frac{1 + \hat{i}/k - (1 + g^k)(1 + g^n)}{\delta n^s} = \frac{1}{1 + \phi}$</td>
<td></td>
</tr>
<tr>
<td>$\phi$</td>
<td>Frisch elasticity (CFE)</td>
<td>$]-1,1]$</td>
<td>$\frac{\partial n^s}{\partial w} \frac{w}{n^s} = \frac{1}{1 + \phi}$</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>CRRA parameter</td>
<td>$\geq 1$</td>
<td>$\frac{\sigma}{\bar{r} - \ln \beta}$</td>
</tr>
<tr>
<td>$\rho$</td>
<td>Declared activities</td>
<td>$]0; 1[$</td>
<td>Schneider et al. [2010]</td>
</tr>
<tr>
<td>$\kappa$</td>
<td>Tax collection cost</td>
<td>$\mathbb{R}$</td>
<td>$\frac{\tau/y}{c/y^\tau_c + \alpha\tau^c + (1 - \alpha)\tau^n - 1}$</td>
</tr>
</tbody>
</table>

**Note:** We use long-run averages of macroeconomic variables to approximate the steady-state expressions of model variables. The calibration methods adopted for the hyper-parameter $\theta = [\beta, \delta, \alpha, \sigma, \phi, \rho, \kappa]$ are based on steady-state expressions and ratios. Frisch elasticity parameter $\phi$ is computed using as an elasticity of labour supply relative to real wages. Tax collection cost $\kappa$ measures the gap between actual tax burden and its implied value using calibrated parameters for the frictionless tax burden level.

The calibrated values for the structural parameters of our model are computed using steady-state values for the relevant macroeconomic aggregates, as underlined by Cooley [1995]. For instance, we use the Cobb and Douglas [1928] production function in equation (3.2.7) in order to calibrate the numerical value of $\alpha$, the capital share of output. Similarly, we use capital accumulation to compute the investment-to-capital ratio in order to calibrate $\delta$, the capital depreciation. We use the standard Euler equation in order to calibrate values for the discount factor, $\beta$, as well as the CRRA parameter, $\sigma$. The CFE parameter, $\phi$, affects the extensive margin of labour supply, so we compute it as a function of the employment elasticity to wages. As mentioned earlier, the Constant Frisch Elasticity (CFE) parameter is debated in the literature: values estimated from macroeconomic aggregates differ significantly from those derived from households surveys. Hall [2009] uses this argument in order to incorporate cross-elasticity between consumption and worked hours. Trabandt and Uhlig [2011, 2012] use this argument in turns to formulate non-separability in the household’s utility function. In our model however, we ignore cross-elasticity between consumption and worked hours, as labour dynamics are more driven by the extensive margin than the intensive margin in developing and emerging economies. The parameter $\rho$ is calibrated in a straightforward way: we use estimates from Schneider et al.
to compute the share of declared and/or legitimate economic activities, $\rho$. The fraction, $1 - \rho$, refers to the size of underground economic activities in GDP. Finally, the parameter $\kappa$ denotes the tax collection cost. We calibrate it to match the discrepancy between the overall tax burden (relative to GDP) and the sum of the contributions of each tax base component with respect to their steady-state values. We use this proxy instead of the indicator used by Yesin [2004] due to the lack of administrative data on resources allocated to tax collection in developing and emerging countries.

Country groups and benchmarks

We use different sub-categories to classify countries in our sample set for several reasons. First, there is no agreement on the set of criteria that breaks down countries into developed economies on the one side, and developing and emerging economies on the other side. Second, a unique criteria is likely to be arbitrary, and may introduce bias in cross-group comparisons. In order to address these limitations, we propose to formulate several sets of criteria in order to consolidate our sample set into various sub-category groups. We focus mainly on two classifications. First, we use the World Bank Atlas method based on an income criterion. The World Bank cut-offs at $12,056 and $955 in real income per capita to create three sub-groups: High, Middle and Low-income country groups. Both Middle- and Low-income groups are treated as developing and emerging economies, while the High-income economies category is considered as a proxy for developed countries. The World Bank further breaks down the Middle-income bracket into Upper-Middle and Lower-Middle sub-groups with $[12,055 – 3,896]$ and $[3,895 – 955]$ in real income per capital, respectively. Second, we use a geographical criterion by creating regional country groups. We exclude High-income countries and create the following sub-groups: Latin America & the Caribbean, Sub-Sahara Africa, Middle-East & North Africa, Central & Eastern Europe, Balkans & Central Asia, and South Asia & Pacific. The main advantage of this criterion is that it is exogenous to other factors that may affect tax rates and revenues.

For robustness checks, we use three other classifications. We first start by assigning an institution-based criterion to define developed countries: G7, core Organisation for Economic Cooperation and Development (OECD) countries and OECD countries. G7 refers to the seven major global economies, namely the United States, United Kingdom, Japan, Italy, Germany, France and Canada. The category Core OECD refers to founding members and countries that have joined the OECD before the 1990s. Category OECD refers to the current membership.\(^3\)

Another criterion we use for our analysis looks at attributes other than income in our country sample. We look at differences from the perspective of institutional quality, using the Freedom House ranking score. Our sample is divided into three sub-categories: Free, Partially Free and not Free per Freedom House scoring method. Finally, we look at our sample set through the prism of economic activities, namely the weight of agriculture and natural resources rents relative to GDP. We create decile-based categories in order to compare on the one hand agrarian versus non-agrarian economies, and resources-rich/poor country groups on the other hand. Results for these classifications are reported in the appendix.

Summary statistics: structural parameters

We calibrate the numerical values of our sample set of 152 countries using macroeconomic aggregates and formulas reported in tables 3.1 and 3.2 respectively. We obtain individual values for each country for the parameter set $\theta = [\beta, \delta, \alpha, \sigma, \phi, \rho, \kappa]$. In this subsection, we start by reporting descriptive and summary statistics for the whole sample. Then, using the subcategories discussed earlier, we compare differences in mean values between the income and regional categories. Table 3.3 reports summary statistics for the whole sample.

\(^3\)As of July 2018.
Table 3.3: Structural parameters - whole sample

<table>
<thead>
<tr>
<th>Statistics</th>
<th>$\beta$</th>
<th>$\delta$</th>
<th>$\alpha$</th>
<th>$\sigma$</th>
<th>$\phi$</th>
<th>$\rho$</th>
<th>$\kappa$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.929</td>
<td>0.028</td>
<td>0.311</td>
<td>2.710</td>
<td>0.379</td>
<td>0.668</td>
<td>0.252</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>0.055</td>
<td>0.023</td>
<td>0.216</td>
<td>2.077</td>
<td>0.637</td>
<td>0.136</td>
<td>1.254</td>
</tr>
<tr>
<td>Median</td>
<td>0.942</td>
<td>0.024</td>
<td>0.268</td>
<td>1.913</td>
<td>0.372</td>
<td>0.663</td>
<td>0.010</td>
</tr>
<tr>
<td>Maximum</td>
<td>0.999</td>
<td>0.150</td>
<td>0.943</td>
<td>13.127</td>
<td>4.158</td>
<td>0.914</td>
<td>9.711</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.559</td>
<td>0.000</td>
<td>0.010</td>
<td>1.021</td>
<td>-4.379</td>
<td>0.312</td>
<td>-0.945</td>
</tr>
</tbody>
</table>

Note: The baseline dataset covers the period 1950-2015. Calibrated values are computed for available data points within this time period. Unweighted averages and other statistics are reported for all 152 countries in the sample. The parameter $\rho$ is computed from Schneider et al. [2010] for the period 1996-2006 and for 132 countries in our sample set. Economic interpretations of structural parameters are reported on table 3.2.

We notice that the sample-wide average values for our structural parameters fall within range of acceptable values in the literature. Cooley [1995] compute credible values using the calibration methods referred to in table 3.2. The parameter $\beta$ denotes the discount factor with a sample-wide average value of 0.929. This implies a long-run average interest rate of 7.6% per annum. This value is pretty high compared to figures used in the literature, namely Cooley [1995] and King and Rebelo [1999]. Notice however that there are a couple of countries whose long run average interest rate skew the mean to lower values for parameter $\beta$. Zimbabwe, Brazil, Ecuador and Mongolia exhibit exceedingly low values for parameter $\beta$. By excluding these countries, we reach the higher sample average of 0.942, which is close to the median value reported on table 3.2. The literature usually calibrates parameter $\beta$ by using the 3-months maturity for the United States Treasury Bills (T-Bills). Their long-run average being at around 1% quarterly, $\beta$ is calibrated at 0.99 or 0.961 in annual terms. Cooley [1995] offer an alternative calibration in which parameter $\beta$ depends on additional parameters. They use the Euler equation at the steady-state in order to extrapolate a value for $\beta$ which is function of capital depreciation $\delta$, capital share of output $\alpha$ and capital-to-output ratio $\bar{k}/y$ at the steady state. Using the numerical values of these parameters, Cooley [1995] calibrate an annual value of $\beta = 0.947$. Hairault and Portier calibrate $\beta$ on French quarterly data, at 0.953 using an annual interest rate of 4.9%. By contrast, Lafargue et al. [1992] and King and Rebelo [1999] calibrate for real interest rate such that $\beta = 0.98$ on an annual basis. For small open economies, Schmitt-Grohé and Uribe [2005] calibrate $\beta = 0.96$ for Canada, which implies an annual interest rate of 4.1%. García-Cicco et al. [2010b] calibrate a parameter value $\beta = 0.922$ for Argentina, using an average interest rate of 8.41% per annum.

For capital depreciation factor $\delta$, we adopt the calibration formula of Cooley [1995]:

$\delta = 1 + \frac{i}{k} - (1 + g^k)(1 + g^n)$. $\frac{i}{k}$ denotes the investment-to-capital ratio, $g^k$ and $g^n$ denote capital stock and demographic growth rates, respectively. By taking into account these growth rates there is a large discrepancy between our calibrated values, and these used in the literature. In our sample, capital depreciation parameter $\delta$ displays a value of 0.028 on average, which is lower than the value typically found in the literature. Hairault and Portier reports a quarterly depreciation rate of 0.0125 for the French economy, which yields an annual value of $\delta = 0.051$. King and Rebelo [1999] assign a close value of $\delta = 0.06$ on the basis of postwar data in the United States. They also admit that a higher depreciation factor of 10% can yield similar results. Trabandt and Uhlig [2011, 2012] also calibrate a close average value $\delta = 0.07$, ranging from 0.048 (Sweden) to 0.098 (Portugal). For emerging economies, García-Cicco et al. [2010b] retain $\delta = 0.1255$ for Argentina, while Aguiar and Gopinath [2007] assign a lower value of $\delta = 0.05$ in their study of business cycles in emerging economies. Despite lower values on average for capital depreciation.
δ, some countries in our sample exhibit double-digits depreciation rates. Azerbaijan, Zimbabwe and Equatorial Guinea all exhibit values larger than 10%.

Parameter α refers to capital share of output, and it is calibrated using capital stock and output per capital in log terms, i.e. \( \alpha = \frac{\ln y - \ln n - \ln z}{\ln k - \ln n} \). The literature calibrates for α a usual value of 1/3, derived from Solow [1957], and his investigation of the Total Factor Productivity (TFP) residual in the United States. García-Cicco et al. [2010b] use a similar value for their simulation of business cycles in Argentina. King and Rebelo [1999] also use the Solow estimate of \( \alpha = 1/3 \). Schmitt-Grohé and Uribe [2005] use a similar value \( \alpha = 0.32 \) to calibrate a small open economy. By contrast, Cooley [1995] assign a slightly higher value \( \alpha = 0.4 \) to capital share of output. They obtain this value by excluding government capital stock and income from the macroeconomic aggregates. Hairault and Portier [2013] and Hairault [2010] both calibrate comparatively higher values for the French economy, with \( \alpha = 0.46, 0.42 \) respectively. The literature has therefore formed a consensus on a range of acceptable values for α, belonging to the interval [0.24;0.43], as reported in Christiano and Fitzgerald [1998]. Our estimates lead to broadly similar values, with a sample average value of 0.31 and a median value of 0.26, which suggests that there are outliers on the upper bound set for parameter α.

Parameter σ denotes the inverse of intertemporal elasticity of substitution among households. It is also the Constant Relative Risk Aversion (CRRA) parameter, with \( \sigma = |U''/U'| \) the ratio of the second and first utility derivative with respect to consumption. The method adopted to calibrate \( \sigma \) uses the standard growth theory as in Barro and Sala-i Martin [2001]. Household’s consumption growth rate at the steady state is proportional to deviations of the interest rate from its equilibrium value, i.e.: \( \Delta \bar{c} = (r - \ln \beta)/\sigma \). CRRA Parameter \( \sigma \) can therefore be written as a function of the average consumption rate and interest rate in long-run, as well as the discount factor \( \beta \). Lucas [2003] estimates consumption growth rate using a linear time trend. We opt instead for the geometric mean to calibrate the average growth rate of household consumption. We observe that 75% of our sample exhibit a \( \sigma \) value of 3.2 and less, which suggest that our calibration method leads to calibrated values consistent with those used in the literature. In the literature, the parameter \( \sigma \) is usually calibrated at a value equal to or greater than one. For instance Cooley [1995] use \( \sigma = 1 \) which implies \( U(c) = \ln c \). In his investigation of welfare costs of the business cycle, Lucas [2003,1990] offers alternative calibrated values for \( \sigma \) ranging from 1 (logarithmic) to 2.5. The consensus in the literature seems to be \( \sigma = 2 \). Schmitt-Grohé and Uribe [2005] calibrate this value for Canada as a small open economy, while García-Cicco et al. [2010b] do the same for Argentina. Aguiar and Gopinath [2007] also adopt a similar value in their study of business cycles in a large set of emerging economies. We depart from the literature by using our own calibrated results, which show yield an average value of \( \sigma = 2.71 \). Although the standard deviation is large (2.07), the median value of \( \sigma = 1.91 \) is much closer to the consensus formed in the literature.

The Constant Frisch Elasticity (CFE) parameter denotes changes in labour supply due to an income shock. In our model, \( \phi \) is the inverse of labour supply elasticity, namely \( \phi = 1/\varepsilon_{s,n} - 1 \) where \( \varepsilon_{s,n} = \frac{\partial s_n}{\partial w} \frac{w}{n} \). The literature does not form a clear consensus as to the appropriate set of values for which it calibrates \( \phi \). In fact, micro-based evidence collected from household survey and field experiments contradicts results from macroeconomic aggregates. Raj Chetty et al. [2013] find that CFE values for labour supply lie between 0.3 and 0.25 for micro-based studies, and 0.25 to 0.5 for macro-based estimations. Garcia-Cicco et al. [2010b] calibrate the CFE parameter at \( \phi = 1.6 \) for Argentina, meaning that the implied labour supply elasticity is 0.384. Aguiar and Gopinath [2007] calibrate their value such that households devote a third of their available time to work at the steady state, which implies a CFE value of 1.77. Our sample value of \( \phi = 0.379 \) implies a labour supply elasticity of 1.64, which is not far away from either the micro- or the macro-based evidence referenced in Raj Chetty et al. [2013]. We should note however that in our sample, 12 countries exhibit a negative value for labour supply elasticity, with an average
value of -1.78. Most of these are located in Central & Eastern Europe and the Baltics, as well as Zimbabwe. This negative elasticity assumes that the household actually decreases its labour supply after a positive income shock. Parameter $\rho$ captures the percentage of declared economic activities over GDP. We report the data compiled by Schneider et al. [2010] as the fraction $1 - \rho$ of undeclared or underground economic activities. On average, declared and/or legitimate economic activities make up for 67% of GDP. The median share is at 66.3% which is close enough to suggest that most countries cluster around the mean with no significant outliers. We can report that only 10% of our sample has a share $\rho$ of declared economic activities below 10% of GDP. Finally, parameter $\kappa$ captures the inefficiencies or cost of collection of taxes. As shown on table 3.2, parameter $\kappa$ captures the gap between the total tax burden, and the contributions of each tax component to total fiscal revenues. The trivial case where $\kappa = 0$ refers to an exact match between the aggregate tax burden on one side, and the individual components of tax revenues on the other. We report a substantial degree of heterogeneity among the countries in our sample. Although average cost of collection is 29.65%, median value is slightly higher at 30.5%. On average, countries in our sample lose a little under 30% of their tax revenues due to a mixture of tax collection inefficiencies, costs and specific domestic legislation. The fact that minimum and maximum values are so far away from each other suggest that there are substantial cross-country differences to discover.

In order to expand on results discussed above, we report in figure 3.1 the histogram and estimated distribution of the structural parameters for our country sample. The Kernel-based density estimates can provide a visual illustration of how our structural parameters are distributed across our country sample set. Although most parameters congregate within range of the usual values adopted in the literature, there are substantial outliers to the distribution of several parameters. As mentioned before, countries with double-digit average interest rate exhibit a low value for the discount factor $\beta$. In total, 15 countries out 152 exhibit a long run average interest rate of 15% or more. This means that all these countries calibrate their respective discount factors at 0.87 or less. These countries are distributed roughly equally across Central and Southern Latin America, Central Asia, Central & Eastern Europe and the Caucasus, as well as Sub-Sahara Africa. Otherwise, the rest of our sample set calibrates values close to these used in the literature.

Regarding capital depreciation $\delta$, we have explained before why our calibrated values are set lower compared to what the literature usually attributes to this parameter. Nevertheless, we do observe some outliers to the right of the distribution, mainly with $\delta$ values at 10% or higher. Three countries exhibit a large depreciation factor, namely Azerbaijan, Equitorial Guinea and Zimbabwe. The remaining countries in our sample set cluster closely to the reported mean in table 3.2. Although parameter $\alpha$ shows a similar shape of distribution, there are more outliers with respect to the usual values of the literature. Using the range [0.24; 0.43] computed by Christiano and Fitzgerald [1998] we find that only 57 countries out of 152 are included. Most of these are High-income countries, which means that the calibration method is sound regardless. This heterogenous distribution is reflected in the small mode to the left, close to 1 in figure 3.1.

CRRA parameter $\sigma$ is more homogenous, with 110 countries out of 152 with a value of 3 or less. Only 16 countries exhibit a CRRA value of 5 or more. Labour supply elasticity and the CFE parameter $\phi$ are closely linked, which is why both are plotted for their respective estimated densities. There is strong clustering of labour supply elasticity around its mean value of 1.86. Similarly, we observe that many countries in our sample set congregate around the mean CFE value of 0.378. Nevertheless, we observe that there are outliers on both tails of the distribution. Labour elasticity has a small cluster of outliers to the right, with very high elasticity values. We report the same for the CFE parameter $\phi$. The distribution of parameter $\rho$ is more homogenous:

4Countries with a low discount factor $\beta$ are: Angola, Armenia, Belarus, Brazil, Ecuador, Ghana, Kazakhstan, Kyrgyzstan, Madagascar, Mongolia, Nicaragua, Paraguay, Uruguay and Zimbabwe. Yemen from The Middle East & North Africa is the only regional outlier.
118 countries of 152 are located in the interval $[0.5; 1]$. The remaining countries exhibit lower values, with the smallest $\rho$ begin 0.312. Finally, collection cost parameter $\kappa$ is mostly set on the interval $[-1; 1]$ with 127 countries. The remaining 25 exhibit a higher value for $\kappa$ which implies a highly efficient collection system. Table 3.4 below reports the calibrated values for our sample set of 152 countries consolidated into sub-categories. We use various sub-groups as proxies for wealthy countries: G7, core OECD, present-day OECD and EMU. The table reports average values for all proxies of developed economies, as well as the remaining countries as stand-ins for developing and emerging ones. We report an average $\beta$ value for the G7 group at 0.964 with a standard deviation of 0.019. It is larger than the core OECD or OECD groups, at 0.957 and 0.953, respectively. Europe also exhibits a large $\beta$ value on average, with 0.958 and 0.957 for the EMU and EU14+US groups, respectively. By contrast, the discount factor $\beta$ value for the remaining 116 countries that are neither in Europe, G7 or the OECD is on average lower with a value of 0.922 and a larger standard deviation of 0.06. The same level of discrepancy is reported for the CRRA parameter $\sigma$. All proxies for wealthy economies exhibit values close to 2, the standard value in the literature. By contrast, average value for $\sigma$ in the rest of the world is higher at 2.9, with a larger standard deviation of 2.29. Another parameter with similar properties is $\rho$, share of declared and/or taxable resources. Average values for our proxies of developed economies range between 0.79 and 0.85 with standard deviations between 0.06 and 0.09. We contrast these values with those computed for the rest of the world, where average $\rho$ stands at 0.62 and a standard deviation of 0.12. Capital share of output $\alpha$ also shares in the same patterns, where we calibrate similar values for all proxies of developed countries. $\alpha$ values for these groups range between 0.33 and 0.36, while developing and emerging economies experience a lower average of 0.31. Parameter $\delta$ offers an additional contrast between our proxies of developed countries, and the rest of the world. Average values for developed countries range between 0.017 and 0.023, while the rest of the world calibrates an average value of 0.03. CFE parameter $\phi$ is relatively low in G7, OECD and European countries, with mean groups ranging between 0.179 and 0.274. For the rest of the world though, the Frisch elasticity parameter is at 0.419, with a larger standard deviation. Finally, we report a heterogenous distribution of $\kappa$ across country groups, whose average value is negative across the board. Given the small size sample of the G7 group, average value for $\kappa$ can be biased by individual countries, such as Italy.
whose collect cost is the highest among G7. Nevertheless, all aver values for the proxy groups of wealthy countries are lower than the rest of the world. The remaining 95 countries in our sample exhibit a group mean of -0.388 with a comparatively larger standard deviation of 0.28. Tables 3.5 and 3.13 provide further categories using income, regions and Freedom House scores as categories.

Although these comparisons provide us with first-hand evidence of cross-country differences, we cannot conclude as to how statistically significant they are. Our results show that the calibrated values we have computed for G7 countries fit well within the range of acceptable values adopted in the literature. However, we are not sure whether calibrated values for developing and emerging economies are statistically different from G7 values. To that effect, we propose to test group means using the G7 group as a benchmark, against OECD, core OECD and the rest of the world as the remaining groups. We use one-way Analysis of Variance (ANOVA) testing. ANOVA posits a null hypothesis that all mean values for our category groups are equal. This is equivalent to an F-test with q constraints, where q is the number of category groups. Using the G7 and high income countries as base level groups, we test differences in mean values for each parameter. We first start by comparing G7 to core OECD, OECD and the rest of the world, then move to income-based and region-based categories.

As far as selected proxies for developed countries go, we report statistically significant differences for some parameters, though many others appear to be similar across group categories. The discount factor $\beta$ is lower in the rest of the world compared to G7 base level, whereas no meaningful differences can be reported as to OECD and core OECD groups. Share of declared/taxable economic activities $\rho$ is significantly lower among newcomers to the OECD relative to G7. This is also the case for the rest of the world. We can interpret these results as follows: regardless of how groups of developed economies are arranged, the discount factor is always higher among the selected proxy group. G7 and OECD groups exhibit a higher $\beta$ value on average, and the difference with developing and emerging economies is statistically significant. We do not report significant differences in terms of capital depreciation and share of output. Similarly, the CRRA $\sigma$ parameter appears to be statistically the same across groups. Only parameter $\rho$ is statistically significant for both newcomers to the OECD and the rest of the world. It suggests that underground economic activities represent a larger share in these economies than G7. We report no statistically significant differences for the other parameters. In order to check for the robustness of our results and the proxies used in table ??, we use the income criterion the World Bank Atlas method.

Table 3.15 reports all differences in means using the World Bank Atlas method. High income countries are identified as those with a real income per capita of $12,056 or more. Middle income countries are split into two categories, Middle-High income countries, whose real income per capita falls within the range [$12,055 - $3,896] and Middle-Low income countries, with range [$3,895 - $955]. Low-income countries are these with real income per capita of $955 and below. Although Middle-income countries are closer in terms of real income per capita to High-income economies, their discount factor $\beta$ is significantly lower. This reflects a higher long-run average interest rate among countries in this group category. As a result, the difference in average $\beta$ between this category and the base level is statistically significant. A similar observation is reported with respect to Middle-Low and Low-income countries. Both exhibit statistically significant differences between their respective average $\beta$ on the one side, and the average $\beta$ parameter for the base level. Using High-income countries as a proxy for developed ones, we can conclude that the discount factor is significantly higher in developed countries than developing and emerging ones.
Table 3.4: Structural parameters - average values per category: G7/OECD vs the rest of the world

<table>
<thead>
<tr>
<th>Group/Parameter</th>
<th>$\beta$</th>
<th>$\delta$</th>
<th>$\alpha$</th>
<th>$\sigma$</th>
<th>$\phi$</th>
<th>$\rho$</th>
<th>$\kappa$</th>
</tr>
</thead>
<tbody>
<tr>
<td>G7 (Mean)</td>
<td>0.964</td>
<td>0.017</td>
<td>0.342</td>
<td>1.959</td>
<td>0.189</td>
<td>0.846</td>
<td>-0.369</td>
</tr>
<tr>
<td>Std.Dev.</td>
<td>(0.019)</td>
<td>(0.012)</td>
<td>(0.054)</td>
<td>(1.037)</td>
<td>(0.108)</td>
<td>(0.059)</td>
<td>(0.161)</td>
</tr>
<tr>
<td>Median</td>
<td>0.967</td>
<td>0.022</td>
<td>0.352</td>
<td>1.524</td>
<td>0.148</td>
<td>0.846</td>
<td>-0.306</td>
</tr>
<tr>
<td>Min</td>
<td>0.928</td>
<td>0.001</td>
<td>0.228</td>
<td>1.113</td>
<td>0.096</td>
<td>0.728</td>
<td>-0.644</td>
</tr>
<tr>
<td>Max</td>
<td>0.986</td>
<td>0.029</td>
<td>0.388</td>
<td>3.985</td>
<td>0.365</td>
<td>0.912</td>
<td>-0.236</td>
</tr>
<tr>
<td>Sample size</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Core OECD</td>
<td>0.957</td>
<td>0.018</td>
<td>0.34</td>
<td>2.135</td>
<td>0.216</td>
<td>0.827</td>
<td>-0.268</td>
</tr>
<tr>
<td>(0.016)</td>
<td>(0.012)</td>
<td>(0.064)</td>
<td>(0.935)</td>
<td>(0.084)</td>
<td>(0.065)</td>
<td>(0.172)</td>
<td></td>
</tr>
<tr>
<td>OECD</td>
<td>0.953</td>
<td>0.021</td>
<td>0.33</td>
<td>2.089</td>
<td>0.249</td>
<td>0.791</td>
<td>-0.255</td>
</tr>
<tr>
<td>(0.021)</td>
<td>(0.013)</td>
<td>(0.083)</td>
<td>(0.864)</td>
<td>(1.079)</td>
<td>(0.084)</td>
<td>(0.187)</td>
<td></td>
</tr>
<tr>
<td>EMU</td>
<td>0.958</td>
<td>0.023</td>
<td>0.36</td>
<td>1.957</td>
<td>0.274</td>
<td>0.768</td>
<td>-0.187</td>
</tr>
<tr>
<td>(0.015)</td>
<td>(0.019)</td>
<td>(0.06)</td>
<td>(0.814)</td>
<td>(1.47)</td>
<td>(0.091)</td>
<td>(0.218)</td>
<td></td>
</tr>
<tr>
<td>EU14US</td>
<td>0.957</td>
<td>0.017</td>
<td>0.348</td>
<td>2.305</td>
<td>0.175</td>
<td>0.818</td>
<td>-0.242</td>
</tr>
<tr>
<td>(0.017)</td>
<td>(0.011)</td>
<td>(0.043)</td>
<td>(1.059)</td>
<td>(0.059)</td>
<td>(0.06)</td>
<td>(0.133)</td>
<td></td>
</tr>
<tr>
<td>Non G7/OECD</td>
<td>0.922</td>
<td>0.03</td>
<td>0.306</td>
<td>2.902</td>
<td>0.419</td>
<td>0.622</td>
<td>-0.388</td>
</tr>
<tr>
<td>(0.06)</td>
<td>(0.024)</td>
<td>(0.244)</td>
<td>(2.297)</td>
<td>(0.413)</td>
<td>(0.123)</td>
<td>(0.28)</td>
<td></td>
</tr>
<tr>
<td>Note: Standard errors reported in parentheses. See comments on table 3.3. Summary statistics are computed for sub-categories.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 3.5: Structural parameters - average values per income category (World Bank Atlas method)

<table>
<thead>
<tr>
<th>Group/Parameter</th>
<th>$\beta$</th>
<th>$\delta$</th>
<th>$\alpha$</th>
<th>$\sigma$</th>
<th>$\phi$</th>
<th>$\rho$</th>
<th>$\kappa$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low Income</strong></td>
<td>0.909</td>
<td>0.03</td>
<td>0.348</td>
<td>3.273</td>
<td>0.521</td>
<td>0.572</td>
<td>-0.456</td>
</tr>
<tr>
<td></td>
<td>(0.087)</td>
<td>(0.03)</td>
<td>(0.29)</td>
<td>(2.829)</td>
<td>(0.246)</td>
<td>(0.09)</td>
<td>(0.263)</td>
</tr>
<tr>
<td></td>
<td>0.916</td>
<td>0.024</td>
<td>0.239</td>
<td>2.698</td>
<td>0.495</td>
<td>0.569</td>
<td>-0.479</td>
</tr>
<tr>
<td></td>
<td>0.559</td>
<td>0.001</td>
<td>0.111</td>
<td>1.075</td>
<td>0.238</td>
<td>0.398</td>
<td>-0.989</td>
</tr>
<tr>
<td></td>
<td>0.999</td>
<td>0.15</td>
<td>0.931</td>
<td>13.127</td>
<td>1.458</td>
<td>0.804</td>
<td>0.303</td>
</tr>
<tr>
<td></td>
<td>23</td>
<td>23</td>
<td>23</td>
<td>23</td>
<td>23</td>
<td>19</td>
<td>23</td>
</tr>
<tr>
<td><strong>Middle Low</strong></td>
<td>0.921</td>
<td>0.025</td>
<td>0.292</td>
<td>2.896</td>
<td>0.456</td>
<td>0.589</td>
<td>-0.419</td>
</tr>
<tr>
<td></td>
<td>(0.05)</td>
<td>(0.018)</td>
<td>(0.255)</td>
<td>(2.572)</td>
<td>(0.242)</td>
<td>(0.126)</td>
<td>(0.231)</td>
</tr>
<tr>
<td></td>
<td>0.929</td>
<td>0.02</td>
<td>0.181</td>
<td>1.874</td>
<td>0.39</td>
<td>0.584</td>
<td>-0.438</td>
</tr>
<tr>
<td></td>
<td>0.803</td>
<td>0.002</td>
<td>0.033</td>
<td>1.044</td>
<td>0.234</td>
<td>0.312</td>
<td>-0.887</td>
</tr>
<tr>
<td></td>
<td>0.997</td>
<td>0.065</td>
<td>0.92</td>
<td>11.235</td>
<td>1.307</td>
<td>0.86</td>
<td>0.211</td>
</tr>
<tr>
<td></td>
<td>34</td>
<td>34</td>
<td>34</td>
<td>34</td>
<td>34</td>
<td>28</td>
<td>26</td>
</tr>
<tr>
<td><strong>Middle High</strong></td>
<td>0.921</td>
<td>0.032</td>
<td>0.29</td>
<td>2.964</td>
<td>0.401</td>
<td>0.628</td>
<td>-0.394</td>
</tr>
<tr>
<td></td>
<td>(0.056)</td>
<td>(0.027)</td>
<td>(0.241)</td>
<td>(1.954)</td>
<td>(0.418)</td>
<td>(0.105)</td>
<td>(0.203)</td>
</tr>
<tr>
<td></td>
<td>0.937</td>
<td>0.024</td>
<td>0.24</td>
<td>2.276</td>
<td>0.403</td>
<td>0.643</td>
<td>-0.418</td>
</tr>
<tr>
<td></td>
<td>0.701</td>
<td>0</td>
<td>0.029</td>
<td>1.15</td>
<td>-0.983</td>
<td>0.367</td>
<td>-0.833</td>
</tr>
<tr>
<td></td>
<td>0.994</td>
<td>0.111</td>
<td>0.944</td>
<td>10.185</td>
<td>2.236</td>
<td>0.865</td>
<td>-0.04</td>
</tr>
<tr>
<td></td>
<td>39</td>
<td>39</td>
<td>39</td>
<td>39</td>
<td>39</td>
<td>33</td>
<td>31</td>
</tr>
<tr>
<td><strong>High Income</strong></td>
<td>0.951</td>
<td>0.024</td>
<td>0.33</td>
<td>2.162</td>
<td>0.304</td>
<td>0.782</td>
<td>-0.242</td>
</tr>
<tr>
<td></td>
<td>(0.026)</td>
<td>(0.016)</td>
<td>(0.116)</td>
<td>(1.202)</td>
<td>(0.896)</td>
<td>(0.09)</td>
<td>(0.287)</td>
</tr>
<tr>
<td></td>
<td>0.955</td>
<td>0.024</td>
<td>0.341</td>
<td>1.78</td>
<td>0.282</td>
<td>0.803</td>
<td>-0.281</td>
</tr>
<tr>
<td></td>
<td>0.832</td>
<td>0</td>
<td>0.085</td>
<td>1.021</td>
<td>-4.379</td>
<td>0.485</td>
<td>-0.785</td>
</tr>
<tr>
<td></td>
<td>0.966</td>
<td>0.074</td>
<td>0.844</td>
<td>7.781</td>
<td>4.157</td>
<td>0.914</td>
<td>0.792</td>
</tr>
<tr>
<td></td>
<td>53</td>
<td>53</td>
<td>53</td>
<td>53</td>
<td>53</td>
<td>49</td>
<td>44</td>
</tr>
</tbody>
</table>

**Note:** Standard errors reported in parentheses. See comments on table 3.3. Summary statistics are computed for sub-categories.

Apart from Middle-High income countries, parameters $\delta$, $\alpha$, $\sigma$ and $\phi$ all appear to be identical across group categories. The differences in mean groups with respect to the base level are not statistically significant, except for the countries whose real income per capita fits in the interval [$12,055 - 3,896$]. In that sense, the literature may be right to apply universal values for its structural parameters. Since there are no obvious differences on average between developed (High-income) countries and developing and emerging economies, we can safely presume that the same calibration for both is appropriate. We observe however that for parameters $\rho$, $\kappa$ there are statistically significant differences alike between the base level and other group categories. Share $\rho$ of declared/taxable resources is substantially higher at 0.782 in High-income countries, whereas Middle-High income countries lose about 16 percentage points from the base level, and Low-income countries lose 22 percentage points on average. Parameter $\kappa$ captures collection costs and tax inefficiencies. We observe that High-income countries exhibit a low level at -0.242. It is substantially lower than the rest of the sample set, with the highest losses for Low-income countries. In comparison, Middle-High income countries lose only 14.2 percentage points of tax revenues above these lost on average by High-income countries. Low-income countries on the other hand, lose almost 22 percentage points with respect to the base level tax inefficiency.

We extend our ANOVA breakdown to regional groups, using High-income countries as our proxy for developed economies. We use the regional breakdown adopted by the World Bank and consolidate the remaining countries in our sample set into the following regions: Latin America & the Caribbean, Sub-Saharan Africa, Middle-East & North Africa, Central & Eastern Europe, Balkans & Central Asia, and South Asia & Pacific. Table 3.6 reports ANOVA regression results. We find similar patterns with respect to differences between High-income countries and other
developing and emerging economies.

Table 3.6: Structural parameters - ANOVA regression results, High Income countries as group base level - regional groups.

<table>
<thead>
<tr>
<th>Variable</th>
<th>$\beta$</th>
<th>$\delta$</th>
<th>$\alpha$</th>
<th>$\sigma$</th>
<th>$\phi$</th>
<th>$\rho$</th>
<th>$\kappa$</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEEBCA</td>
<td>-0.044***</td>
<td>0.017**</td>
<td>0.059</td>
<td>1.405**</td>
<td>0.047</td>
<td>-0.251***</td>
<td>-0.104</td>
</tr>
<tr>
<td></td>
<td>(0.015)</td>
<td>(0.006)</td>
<td>(0.062)</td>
<td>(0.566)</td>
<td>(0.183)</td>
<td>(0.030)</td>
<td>(0.081)</td>
</tr>
<tr>
<td>LATCAB</td>
<td>-0.049***</td>
<td>-0.003</td>
<td>-0.091</td>
<td>1.382***</td>
<td>0.140</td>
<td>-0.213***</td>
<td>-0.181**</td>
</tr>
<tr>
<td></td>
<td>(0.013)</td>
<td>(0.006)</td>
<td>(0.056)</td>
<td>(0.511)</td>
<td>(0.166)</td>
<td>(0.027)</td>
<td>(0.071)</td>
</tr>
<tr>
<td>MENA</td>
<td>0.007</td>
<td>0.012</td>
<td>-0.011</td>
<td>-0.610</td>
<td>0.071</td>
<td>-0.083**</td>
<td>-0.118</td>
</tr>
<tr>
<td></td>
<td>(0.018)</td>
<td>(0.008)</td>
<td>(0.078)</td>
<td>(0.715)</td>
<td>(0.232)</td>
<td>(0.035)</td>
<td>(0.093)</td>
</tr>
<tr>
<td>SEAPAC</td>
<td>-0.012</td>
<td>-0.001</td>
<td>-0.09</td>
<td>-0.224</td>
<td>0.034</td>
<td>-0.115***</td>
<td>-0.228***</td>
</tr>
<tr>
<td></td>
<td>(0.014)</td>
<td>(0.006)</td>
<td>(0.060)</td>
<td>(0.553)</td>
<td>(0.179)</td>
<td>(0.028)</td>
<td>(0.086)</td>
</tr>
<tr>
<td>SUBSAF</td>
<td>-0.039***</td>
<td>0.006</td>
<td>-0.007</td>
<td>1.138***</td>
<td>0.180***</td>
<td>-0.200***</td>
<td>-0.193***</td>
</tr>
<tr>
<td></td>
<td>(0.011)</td>
<td>(0.005)</td>
<td>(0.047)</td>
<td>(0.428)</td>
<td>(0.139)</td>
<td>(0.023)</td>
<td>(0.059)</td>
</tr>
<tr>
<td>Base</td>
<td>0.951***</td>
<td>0.024***</td>
<td>0.330***</td>
<td>2.162***</td>
<td>0.304***</td>
<td>0.782***</td>
<td>-0.242***</td>
</tr>
<tr>
<td></td>
<td>(0.007)</td>
<td>(0.003)</td>
<td>(0.030)</td>
<td>(0.272)</td>
<td>(0.088)</td>
<td>(0.014)</td>
<td>(0.038)</td>
</tr>
</tbody>
</table>

Available data for 132 countries for $\rho$, 127 countries for $\kappa$. Standard errors are reported in parentheses. Level of significance is denoted with stars. Legend: * < 1%, ** 5% and * 10%. Intercept reports High-income countries mean group and level of significance. Estimated coefficients report differences in mean groups. CEEBCA: Central & Eastern Europe and Central Asia. LATCAB: Latin America and the Caribbean. MENA: Middle East & North Africa. SEAPAC: South Asia & the Pacific. SUBSAF: Sub-Sahara Africa

All regional groups excluding South Asia & the Pacific and MENA exhibit a lower average discount factor $\beta$ than the High-income group. This translates into a higher average long-run interest rate in the three regional groups with respect to the base level of High-income countries. The Central & Eastern Europe and Central Asia group exhibits a statistically significant larger depreciation factor $\delta$, whereas no significant group differences have been reported with respect to capital share of output $\alpha$. All regional groups exhibit a smaller share $\rho$ of taxable resources with respect to High-income countries. Countries in Central & Eastern Europe, Central Asia, Latin America and Sub-Sahara Africa all exhibit a larger average value for CRRA parameter $\sigma$. High-income country group computes an average value of 2.16, close to the standard value adopted in the literature. Three regional groups differ substantially from this benchmark, while MENA and South Asia & Pacific appear to exhibit no statistically significant differences with the base level of 2.16. Apart from Sub-Sahara Africa, no other regional group exhibits statistically significant differences with the CFE $\phi$ parameter for the base level. Average value for CFE is 0.304 for High-income countries, whereas Sub-Sahara Africa exhibits a larger average value of 0.484, a difference of 0.18 and statistically significant.

The consistence of ANOVA results confirms the soundness of our calibration strategy. Although some parameters appear to be impervious to group categories, some others exhibit tremendous differences between groups and base levels. Capital share of output $\alpha$ does not differ from one group to the other, whereas share of taxable and/or declared economic activities is systematically lower among countries used as proxies for developing and emerging economies. The same is observed for the CFE parameter $\phi$, with the exception of the regional category and Sub-Sahara Africa. Parameters $\phi$ and $\alpha$ are critical to plotting capital and labour Laffer tax
curves respectively. They determine their shapes, as well as their respective extreme and peak tax rates.

From these ANOVA regression results, we can conclude that country-specific calibrations are preferable to using standard values from the literature. This is the case for these parameters with different mean values as well as these similar across category groups. We find that some parameters can be safely calibrated for developing and emerging economies using values for developed ones. Nevertheless, significant differences between the two groups remain, and our calibration strategy makes provisions for these cases.

**Estimation - GMM**

Although calibration has been a staple of General Equilibrium models, there is much criticism to be made of its use. Reliance on long run averages and ratios does not always provide accurate measurement of numerical values for structural parameters. Too often, the literature mentioned above does not delve into the rationale behind values assigned to some parameters. In addition, there are frequent contradictions between micro-based estimates derived from panel studies, and macro-based aggregates with time series analysis. CFE parameter $\phi$ in our model is an apropos instance of the limitations of calibration. Finally, as noted in [Blanchard 2018], the literature frequently relies on an unconvincing ad hoc mixture of Bayesian estimation and calibration.

We propose to offer an additional set of estimated parameter to the calibration results reported above. [Favero 2001] and [Canova 2007] discuss at length the pitfalls of econometric misspecification for structural parameters. Bad econometrics may yield a robust or consistent estimator, yet one with no obvious intuitions as to its economic interpretation. To that effect, we use Generalised Method of Moment in order to provide estimates of the parameter set $\theta = [\beta, \delta, \alpha, \sigma, \phi]$. We denote moments $g(\theta, X)$ where $X$ is a matrix of macroeconomic variables. $g(.)$ are moments derived from the optimality conditions of our model. The GMM estimator seeks to minimise the following criterion:

$$
\arg \min_\theta \left[ \frac{1}{T} \sum_{t=1}^{T} g(\theta, X) \right]' W^{-1} \left[ \frac{1}{T} \sum_{t=1}^{T} g(\theta, X) \right] \quad (3.3.1)
$$

Where $W$ is the variance-covariance matrix, $T$ is the time period of aggregate macroeconomic variables incorporated in moments $g(\theta, X)$. $W^{-1}$ weights moments inversely commensurate to their variance in order to minimise the GMM criterion in equation (3.3.1). Given our use of annual data, we are limited in the number of data points per country. The time period $T$ is short, as we get at most 64 observations per variable. In order to improve our estimator, we adapt the procedure laid out in [McFadden 1989] used for a Simulated Method of Moments (SMM). He states that the SMM method is handy when the moment function has an intractable analytical expression, yet is easy to simulate. In our case, intractability comes from the small sample size from which observations are drawn. All conditions for the practical use of SMM are observed in our case: the Monte Carlo simulation are based on well-behaved functions, and are easily calculated using just-identified instruments. The asymptotic variance-covariance of estimator $\hat{\theta}$ is computable. We use our limited sample to generate a large set from which we draw our GMM/SMM estimator. For each country, we compute the optimisation programme in equation (3.3.1) using 1,000 draws from the available data points. This allows us to compute an estimator and its standard error. Moments $g(\theta, X)$ write:
\[
\begin{pmatrix}
\frac{y_t - z_t - n_t}{k_{t-1} - n_t} \\
\frac{1 + r_t}{1 + r_t}
\end{pmatrix}
\]

We then compare our results with those of the standard calibration strategy using estimated densities for both methods. Table 3.7 below reports the summary statistics of our estimates for the whole sample. GMM estimates are somewhat lower compared to the calibrated values reported in table 3.3. This can be explained by the fact that there are more outliers to the left-hand side of the distribution for each parameter. Indeed, almost all structural parameters reported in table 3.7 exhibit a null minimal value, something that was not reported for calibrated values in table 3.3. Nonetheless, calibrated and estimated median values are much closer to each other, which is a testimony to the robustness of the calibration strategy laid out in the previous section. Estimated results show that calibration is a parsimonious method for attributing numerical values. Our results also show that calibration can provide meaningful values to the model’s structural parameters. We provide additional evidence that GMM estimates and calibrated values describe the same distribution for core structural parameters in our model. Figure 3.2 below plots the estimated densities for both GMM and calibrated values.

Table 3.7: Structural parameters - GMM estimations.

<table>
<thead>
<tr>
<th>Statistics</th>
<th>(\alpha)</th>
<th>(\beta)</th>
<th>(\delta)</th>
<th>(\sigma)</th>
<th>(\phi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.296</td>
<td>0.881</td>
<td>0.026</td>
<td>2.523</td>
<td>0.361</td>
</tr>
<tr>
<td>Mean (Calibration)</td>
<td>0.311</td>
<td>0.929</td>
<td>0.028</td>
<td>2.710</td>
<td>0.379</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>0.221</td>
<td>0.215</td>
<td>0.023</td>
<td>2.128</td>
<td>0.641</td>
</tr>
<tr>
<td>Median</td>
<td>0.259</td>
<td>0.941</td>
<td>0.022</td>
<td>1.792</td>
<td>0.365</td>
</tr>
<tr>
<td>Median (Calibration)</td>
<td>0.268</td>
<td>0.942</td>
<td>0.024</td>
<td>1.913</td>
<td>0.372</td>
</tr>
<tr>
<td>Min</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-4.379</td>
</tr>
<tr>
<td>Max</td>
<td>0.944</td>
<td>0.999</td>
<td>0.150</td>
<td>13.126</td>
<td>4.157</td>
</tr>
</tbody>
</table>

**Note:** Baseline dataset spans the period 1950-2015. GMM estimation sampled 1000 non-negative observations from available data points, with replacement. Moments \(g(\theta, X)\) are just-identified, using the same number of instruments as there are moments. The parameter set vector \(\theta\) minimises the criterion set out in equation (3.3.1). Yellow rows report calibrated values of table 3.3 for comparison. Summary statistics are reported un-weighted for economies in the sample set. Standard errors are reported for the whole sample set of 152 countries. Individual standard errors are reported in the annex.

Comparison between densities for calibrated and estimated parameter values suggest that both methods yield essentially the same results. We can describe the same bimodal distribution for parameter \(\alpha\) capital share of output. Most countries cluster around the interval \([0; 0.4]\) whereas a small model is observed around 0.8. The discount factor \(\beta\) replicate similar properties, with a large cluster around a value of \(\beta = 0.95\) (or a long-run interest rate of 5.2%). Estimated values for capital depreciation \(\delta\) are for the most part lower than 5%. They replicate adequately the distribution of calibrated values, which suggests that the method advocated by Cooley [1995] fits well most countries in our diverse sample set. We report similar estimated results for
CRRA parameter $\sigma$ in terms of clustering around acceptable values. Most countries see their estimated $\sigma$ parameter fall within range of $[1; 3]$. This interval comprises the oft-used value of 2 in the literature mentioned earlier, and the estimated distribution fits that of calibrated values. Our estimations also confirm the calibration strategy adopted for CFE parameter $\phi$. There is significant clustering around the mean value of 0.380 the same way we reported for calibrated values. Overall, GMM estimates confirm the calibration strategy and its results as laid out in the previous section.

![Figure 3.2: Histogram and estimated density - GMM vs calibrated structural parameters](image)

Note: See comments on tables 3.3 and 3.7. Estimated densities are computed using the Normal kernel.

Results reported in table 3.7 are better illustrated with the estimated densities for calibrated and estimated values of the model’s structural parameters. We have used in this section the standard calibration methods advocated in the literature. The parsimonious specifications adopted for this model have yielded adequate values for our sample set. Calibrated values for developed economies fall well within range of acceptable and usual values adopted in the literature, while most developed and emerging economies calibrate comparable values. We have then used GMM estimation to test the robustness of our calibrated values, and confirm that they are. We now move to building the Laffer curve for our model.

### 3.4 Results - the micro-founded Laffer curve

In this section, we use calibrated values for our structural parameters to build country-specific Laffer curves. In the baseline model, we use equations (3.2.13) and (3.2.17), and calibrated values computed in the previous section. We study the properties of Laffer tax curves, their respective tax peak rates and revenues. We then move to the extension of imperfect governance to our model, and compare their Laffer curves.

Figure 3.3 reports median Laffer labour and capital tax rate curves for the sample set of 152 countries. We observe the standard shape of the Laffer curve, with increasing revenues for low tax rates, until the curve reaches its peak. Beyond their respective extrema, tax revenues decline until they reach zero at 100% tax rate. Based on the calibrated values of our sample
set, the median country exhibits peak tax rates for labour and capital at 19.72% and 34.03%, respectively. We also observe that tax revenues for labour decline at a faster pace when taxes are set past their peak value. Trabandt and Uhlig [2011, 2012] report higher values for their sample set of EU-14 countries and the United States. They compute that maximum labour tax rates in their sample set are set between 51% and 72%. They also compute high peak rate values for capital taxes, set between 44% and 64%. The Laffer curve shapes are also different, both capital and labour tax revenues are skewed sharply to the left, hence the higher peak rates.

Baseline model

Income group categories

Using the sub-categories delineated in the previous section, we first start by using the World Bank Atlas method of income group. We create a proxy for developed economies with the High-income category, while developing and emerging economies are consolidated into the remaining income category groups. Figure 3.5 reports median curves for labour and capital taxes per income group. Each subplot compares the Laffer tax curve for High-income and other income country groups.

Middle-Low income countries exhibit the highest median peak labour tax rate at 21.5%. High-income economies are at a lower peak rate of 17.8%, while the median Low-income country computes a peak tax rate of 15.6%. Middle-high income economies exhibit the lowest median of all income groups at 11.2%. In addition, the Laffer labour tax curve, is higher in Low-income countries, compared to that of our proxy group for developed economies. Such a counter-intuitive result runs counter to expectations that governments in developing and emerging economies experience more difficulties in extracting fiscal revenues. We would except that non-High-income countries would exhibit a lower Laffer curve and skewed to the left in comparison with High-income countries. On the contrary, the baseline model predicts that developing and emerging economies are able to tax labour at a higher or similar rate, and extract higher tax revenues than High-income countries. We account for this paradoxical result by recalling the after-tax labour supply expression in equation (3.2.13). Household labour supply is an increasing function of the consumption-to-output ratio. This means that labour tax revenues themselves are increasing in household consumption share of output. This ratio is highest among low-income countries: High-income countries exhibit an average consumption ratio of 0.56, while

Figure 3.3: Median Laffer curve for capital and labour taxes. Medians are computed for the whole sample set, 152 countries.
low-income countries report a higher average ratio of 0.74. Figure 3.5 reports the distribution of consumption share of output per income group, and illustrates the discrepancy. At the steady state, a large share of output allocated to consumption means that the household is likely to increase its labour supply if income decreases. This means that it is inelastic to taxes, hence higher tax revenues. Given that low-income countries exhibit on average a high consumption-to-output ratio, it is expected that they would yield commensurately higher labour tax revenues. The importance of consumption share of output is such that it accounts for 80% of the gap in tax revenues between low- and High-income countries. The consumption ratio also explains to a similar degree the gap between developed economies and the other income groups.

We observe that peak rate values for our proxies of developed and developing and emerging economies are close to each other. High-income countries exhibit the lowest median value of 29.5%. All other income country groups compute median peak rates between 31% and 33%.
Nevertheless, we report significant discrepancies in tax revenues between High-income and other income group economies. The largest gap in fiscal revenues is observed between high- and middle-high income country groups. The latter raise twice as much as the former in the neighbourhood of their respective tax rate peaks. We explain the discrepancy in tax revenues with differences in labour supply, productivity and capital returns (real interest rate). Recall that low-income countries exhibit a higher consumption share of output, which makes labour in these economies inelastic to taxes. As a result, capital tax revenues are also higher in low- and middle-low income countries. In addition, we also report significant cross-country differences in productivity growth rates. TFP growth is higher in developing and emerging economies on average, as productivity growth rates decrease with real income per capita. According to equation (3.2.17) after-tax capital stock is an increasing function of productivity growth rate at the steady-state. We compute an average High-income productivity growth rate of 2.5%, while developing and emerging economies experience a higher average growth on average. We find that the productivity differential accounts for 45% of the discrepancy in capital tax revenues between high- and middle-low income countries. In addition, low- and middle-low income countries exhibit higher interest rates on average than middle high- and High-income economies. Differences in average interest rates contribute positively to capital tax revenues, as differences in interest rate levels contribute an additional 50% in explaining differences of capital tax rates between developed economies on the one hand, and emerging and developing economies on the other.

Regional group categories

We proceed with a similar analysis for regional groups. We use High-income countries as a proxy for developed economies, while the remaining countries in our sample set are consolidated into five regional areas: Latin America & the Caribbean, Sub-Sahara Africa, Middle-East & North Africa, Central & Eastern Europe, Balkans & Central Asia, and South Asia & Pacific. Figure 3.6 reports Laffer labour tax curves for the median country in each regional group category. It compares the median Laffer tax curve of High-income countries against that of each regional group.

![Figure 3.6: Median Laffer labour tax curves. Sample set broken down into regional groups.](image)

The common feature to all five regional groups is that their respective median peak tax revenues are higher than the median peak for High-income countries. There are different levels of discrepancy in tax revenues, with Latin America & Caribbean and the Middle-East & North
Africa exhibiting the largest gaps. At peak revenues, the two regional groups raise 2.77 and 1.71 times more tax revenues than the median High-income country, respectively. South Asia & Pacific is close behind with peak revenues at 1.38 times these of High-income countries.

We have shown earlier that household consumption share of output accounts for an important fraction of the gap in median tax revenues. We extent this analysis to all core components of after-tax labour supply for each regional group. Table 3.8 reports the respective contributions of consumption-to-output ratio, capital share of output $\alpha$ and CFE parameter $\phi$ to the gap in labour tax revenues between each regional group and High-income countries. Table 3.8 reports countries in Latin America and South Asia with the largest gaps in tax revenues relative to High-income countries. Results in both regional groups are quite sensitive to differences in Frisch elasticity, as can be seen from its contribution to the gap in median tax revenues. In South Asia, differences in CFE value are enough to account for almost 80% of the gap in median tax revenues with High-income countries. Similarly, we report a large effect of CFE parameter $\phi$ in Latin America. Differences in median tax revenues can be explained up to 86% by differences in median values for the Frisch elasticity between that regional group, and these of developed countries. To a lesser degree, labour supply elasticity $\phi$ also pleases an important role in the MENA group, since 40% of the gap in median tax revenues can be explained by differences in CFE $\phi$ values.

<table>
<thead>
<tr>
<th>Regional group</th>
<th>Median gap</th>
<th>C/Y</th>
<th>$\alpha$</th>
<th>$\phi$</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.E. Europe, Balkans &amp; C. Asia</td>
<td>1.65</td>
<td>20.21</td>
<td>1.97</td>
<td>25.47</td>
</tr>
<tr>
<td>Latin America &amp; Caribbean</td>
<td>3.09</td>
<td>26.10</td>
<td>.</td>
<td>86.54</td>
</tr>
<tr>
<td>MENA</td>
<td>1.40</td>
<td>27.53</td>
<td>15.17</td>
<td>40.08</td>
</tr>
<tr>
<td>South Asia &amp; Pacific</td>
<td>2.87</td>
<td>2.09</td>
<td>3.12</td>
<td>79.21</td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>1.21</td>
<td>70.92</td>
<td>16.17</td>
<td>.</td>
</tr>
</tbody>
</table>

**Note:** Median gap reports the ratio of median tax revenues between regional groups and High-income countries. Contributions (%) of structural parameters in after-tax labour supply are computed by substituting each component individually by its median value of High-income countries and plugging it in labour tax revenues for each regional group.

For other regional groups however, consumption-to-output remains a key component to account for differences in peak tax rates with the benchmark group of developed economies. The discrepancy in median tax revenues between developed economies and Sub-Saharan Africa is accounted for at 71% by differences in household consumption ratio $C/Y$. For labour tax revenues, household supply is determined by two key components, namely consumption share $C/Y$ and Frisch elasticity $\phi$. The income-based criterion suggests that the former matters a lot in the Laffer labour tax curve. The region-based criterion suggests that while the consumption ratio is still an influential factor for some regional groups, most others are more sensitive to the Frisch parameter. In any case, we have presented a convincing argument to account for the counter-intuitive result of higher tax revenues in developing and emerging economies relative to developed ones.

We extend the same analysis to capital tax revenues for regional groups and High-income countries. In contrast to labour taxes, there is a great deal of heterogeneity in tax revenues between developed countries on one side, developing and emerging economies on the other. Some regional groups replicate the same counter-intuitive result of higher tax revenues than developed countries, while others fit the more believable outcome of lower tax revenues. It is
expected that developing and emerging economies would raise a lower amount of tax revenues out of capital taxes, because they have a lower level of capital stock to begin with. Nevertheless, there are other factors that can belie this prediction, as it is the case for many regional groups reported in figure [3.4]. The figure below reports median Laffer capital tax curves for each regional group, compared against the benchmark category of developed economies. Two outliers exhibit extreme shapes for their respective tax revenues. The median countries in Eastern Europe & the Balkans, as well as Sub-Sahara Africa can raise respectively 8.5 and 3.5 times more tax revenues than High-income economies at peak revenues. Latin America raises 40% more tax revenues than developed economies, while the two remaining regional groups exhibit Laffer curves below that of the median High-income country. Contrary to after-tax labour supply, there are more parameters and steady-state variables involved in the expression of after-tax capital stock. In particular, capital tax revenues are also a function of interest rate (net of depreciation) and labour supply itself. We concentrate on these variables and parameters that are key to explain the gap in capital tax revenues between developed economies and other regional groups. We identify labour, net interest rate and productivity as likely candidates to account for the gap in tax revenues. Labour has been identified through its own dynamics, as discussed above. Net real interest rate accounts for the availability of capital stock.

Figure 3.7: Median Laffer capital tax curves. Sample set broken down into regional groups.

Paradoxically, high tax revenues from capital may be due to its own scarcity, since it boosts interest rates. Because these are the expression of marginal productivity of capital, high interest rates are at once the expression of low capital stock, and a lucrative source of fiscal revenues for the government. Productivity is the third candidate, with emerging and developing economies exhibiting a higher productivity growth rate than developed countries. Other parameters, such as $\alpha$ and $\beta$ account for the residual contributions that neither candidates has explained. Table 3.9 reports the contributions of each component to the gap in median capital tax revenues between each regional group and High-income economies. We focus on these groups with significant positive gaps with the benchmark category. Table 3.9 shows that Eastern Europe, Balkans & Central Asia could extract more than ten times the amount of tax revenues developed economies can obtain from their capital stock. Labour supply contributes a little over half to this gap in tax revenues, while differences in productivity growth accounts for a little over a fifth. A slightly different contribution breakdown can be reported for Latin America & Caribbean. Differences in productivity are the primary component to explain the gap in tax revenues, with 37% of it
attributable to TFP growth. Labour supply contributes about a third of the gap in tax revenues, while net interest rate accounts for almost a fourth of differences in median tax revenues between Latin America and our proxy for developed countries. Sub-Saharan Africa tends to replicate a breakdown similar to that of Eastern Europe & Central Asia, with 61% of the gap between its median tax revenues and these of developed countries attributable to differences in levels of labour supply. All in all, the three candidate variables and parameters can account for 83% to 93% of the gap in median capital tax revenues between developing and emerging economies on the one side, and developed countries on the other.

Table 3.9: Median gap in tax revenues and relative contributions (%) of labour supply components.

<table>
<thead>
<tr>
<th>Regional group</th>
<th>Median gap</th>
<th>$\bar{n}$</th>
<th>$\bar{\tau}$</th>
<th>$\bar{\bar{r}} - \delta$</th>
<th>$\bar{z}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.E.Europe, Balkans &amp; C.Asia</td>
<td>10.29</td>
<td>50.63</td>
<td>18.29</td>
<td>21.27</td>
<td></td>
</tr>
<tr>
<td>Latin America &amp; Caribbean</td>
<td>1.57</td>
<td>31.17</td>
<td>24.46</td>
<td>37.59</td>
<td></td>
</tr>
<tr>
<td>MENA</td>
<td>0.52</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td></td>
</tr>
<tr>
<td>South Asia &amp; Pacific</td>
<td>0.34</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>4.56</td>
<td>60.67</td>
<td>12.76</td>
<td>10.32</td>
<td></td>
</tr>
</tbody>
</table>

Note: Median gap reports the ratio of median tax revenues between regional groups and High-income countries. Contributions (%) of structural parameters in after-tax labour supply are computed by substituting each component individually by its median value of High-income countries and plugging it in labour tax revenues for each regional group.

This section has shown that the Laffer labour tax curve in the baseline model yields counter-intuitive results. The median emerging and developing country is predicted to raise more tax revenues than the median developed country. Differences in parameter and ratio values account in large part for this result. Households in countries with high consumption-to-output ratio are likely to exhibit labour supply inelastic to taxes. As a result, governments in developing countries can extract higher tax revenues from labour. Similarly, countries with a high Frisch elasticity parameter $\phi$ are likely to have a low labour supply elasticity. The respective contributions of consumption share $C/Y$ and Frisch elasticity $\phi$ varies cross-categories. The income-based criterion identifies the former as the main driver of discrepancies in median tax revenues, while the region-based criterion attributes differences in labour supply elasticity for the most part.

Capital stock is also sensitive to the way the sample set is consolidated into group categories. The income-based criterion delivers a similar counter-intuitive prediction that developing and emerging economies will raise more capital taxes than developed ones. By contrast, the region-based criterion identifies two regional areas where developed economies are the ones with higher median tax revenues. Differences in capital tax revenues and the Laffer curve are accounted for with three major components of after-tax capital returns. Countries with low capital stock typically exhibit higher real interest rates (net of depreciation). This inflates capital tax revenues compared against developed economies with low interest rates, but higher capital stock. Productivity also plays a role in explaining the gap in median capital tax revenues. Developing and emerging economies experience higher productivity growth rates on average, and that has a positive impact on capital stock at the steady-state. Finally, labour dynamics influence after-tax capital returns, and all counter-intuitive results for the Laffer labour tax curve affect capital tax revenues as well.
Extensions: Underground economy and tax collection costs.

Underground economy: partial access to the tax base.

The baseline model describes the relationship between tax rates and fiscal revenues. These are decreasing in the tax rate when it is set beyond its peak value. Nevertheless, the model assumes that tax authorities can assess the whole tax base for their revenues. Such an assumption is not realistic, in that domestic legislation may allow for deductions and loopholes. Furthermore, the government may be unable to tax these economic activities that are underground and/or undeclared. With that in mind, the first extension of our model assumes that tax authorities can only assess a fraction \( 0; 1 \) of their tax base. The model is run through the numerical values calibrated for our sample set of 152 countries. We compare our results with those of the baseline predicted outcome. Figure 3.8 reports the median Laffer curves for capital and labour under both specifications. It compares the Laffer curves of the baseline model, where tax authorities have full access to their tax base, against the extension where economic activities are declared only at a fraction \( p \in [0; 1] \).

![Figure 3.8: Median Laffer curve for capital and labour taxes - full \( (p = 1) \) and incomplete access to the tax base. Medians are computed for the sample set of 152 countries.](image)

The baseline model predicts that peak tax rates for capital and labour will be function of country-specific parameters and steady-state variable values. For labour, the peak rate is a function of its share of output \( 1 - \alpha \), consumption ratio \( C/Y \) and CFE parameter \( \phi \). The first two contribute positively to tax revenues through a revenue effect. A high Frisch parameter value denotes a household with low elasticity to taxes, which means that fiscal authorities can extract higher revenues as well. For capital, the same dynamics apply as it is increasing in labour. Capital tax revenues are also increasing in productivity growth rate \( z \) and the discount factor \( \beta \). Countries with low capital stock as most developing and emerging economies are, can makeup in revenue shortfall with higher returns on capital.

The neo-classical framework used in this paper/chapter predicts ambiguous results. On the one hand, a low value for parameter \( \rho \) translates into a large share of underground economic activities that go untaxed. As a result, there is a smaller wedge effect, since the tax burden on overall economic activities is low. The tax base, be it capital, labour or consumption, is larger in comparison to the case of full taxation \( p = 1 \). On the other hand, although a low value for parameter \( \rho \) leads to fewer distortions and a larger tax base, the government does not benefit. Indeed, a low value for \( \rho \) means that the effective tax rate is \( \rho \tau \) instead of \( \tau \). As a result, tax revenues are low as well.

The extension model builds on the assumption of partial access to the tax base as a way to explain further the counter-intuitive results. In this analysis, we use the High-income country group in the baseline model as a counterfactual for developing and emerging economies. We argue that it is the relevant benchmark because the fiscal systems of our proxy for developed
economies, the High-income country group, are reportedly more efficient than those of developing
and emerging countries, thanks to the high quality of their institutions. This link has been
documented exhaustively in the literature. [Borge et al. 2008] establish a link between insti-
tutions, democracy and fiscal efficiency. [Alonso and Garcimartín 2013] focus on institutional
quality and its interactions with sound tax systems. High institutional quality allows citizens
to scrutinise the use of taxes the government raises. As a result, fiscal authorities have every
incentive to make their tax system as efficient as possible. Pertinent use of fiscal revenues has
also been mentioned in [Stroup 2007] where economic freedom is found to be well correlated
with efficient use of taxes to fund public goods. In this case, economic freedom is equated to
the rule of law, protection of patents and property rights, all of which are guaranteed by sound
and good quality institutions. Another way the literature deals with the link between institu-
tional quality and taxes is advocated by [Tanzi and Zee 2000]. He looks at the constitutional
constraints imposed upon governments and their ability to raise taxes. Quality of institutions
is determined through how well these constitutional constraints work to prevent governments
from raising taxes through ad hoc or arbitrary decisions.

The elements discussed above supply the justification for using the Laffer tax of High-income
countries in the baseline model as a benchmark. The significant differences in structural param-
eter values between High-income and other country groups are such that we need to focus on the
exclusive effects of parameter $\rho$ on peak tax rates and revenues. The comparison is only relevant
if the benchmark does not exhibit issues related to tax inefficiencies. Given that High-income
countries are proven to have fairly efficient tax systems, it makes sense to use the baseline model
as a reference point. Furthermore, in using the baseline High-income Laffer curve, we focus on
the sole effects of partial access to the tax base. Differences between the High-income baseline
Laffer curve and those of developing and emerging economies in the extension model can be
accounted for thanks to differences in values for parameter $\rho$. Finally, partial access to the tax
base is the only component in the model where policymaking is actionable. In this neoclassical
model, there is little in the way of implementing a fiscal policy beyond raising or cutting taxes
along the Laffer curve. By using the baseline High-income Laffer curve as a reference, we can
assess the importance of gains in tax revenues where governments in developing and emerging
economies decide to expand their tax base, rather than raise their tax rates.

A large size of underground economic activities relative to GDP is relevant to our study of
the Laffer curve. In comparing values for parameter $\rho$, we find that declared economic activities
make up for a larger share of output in developed economies than in developing and emerging
ones. Mean and median values for $\rho$ among the High-income country group are 0.782 and
0.803, respectively. For all remaining countries - proxies for developing and emerging economi-
the values are 0.601 and 0.598 in mean and median, respectively. Results from the ANOVA
regressions in tables 3.15 through 3.6 conclude that there are statistically significant differences
between High-income economies and all other countries in our sample set. The importance of
underground/undeclared economic activities manifests itself through the government’s inability
to raise more taxes than they would like to. The effects of partial taxation are in on themselves
ambiguous. On the other hand, a large share of undeclared economy means that they are not
subjected to taxation. As a result, the distortionary effects of the tax wedge are limited to
share $\rho$. The effective tax burden is such that it encourages an extension of the tax base.
Unfortunately, the government does not get to benefit from this happenstance, since it can only
tax $\rho \tau$ rate on its base. The neoclassical framework we have adopted to build the Laffer curve
predicts that the latter effect will dominate. In order to prove this, we look at the expressions
of after-tax labour supply and capital stock of the extension model, namely equations (3.2.20)
and (3.2.21). Under partial access to the tax base, labour supply $n^*(\tau,p)$ is larger than $n^*(\tau)$
where $p = 1$, thanks to the lower wedge effect $\varphi(\tau,p) \geq \varphi(\tau)$. Nevertheless, tax revenues in
the extension model are lower because the effective tax rate is $\rho \tau$ and not $\tau$ as in the baseline
model. This is due to fact that $\rho \tau$ dominates over the tax base effect. The extent to which the
The tax effect dominates is determined by the numerical values assigned to CFE parameter \( \phi \). A high value means that labour supply is inelastic to taxes and therefore to the wedge effect. As a result, there is likely to be little effect in terms of tax revenues. On the contrary, a low value for parameter \( \phi \) means that the household is very elastic in its supply to taxes. As a result, the base effect may be large enough to alleviate the tax effect on revenues.

In addition, when the tax base expands, the peak rate shifts to the right and increases. Similarly, the potential for tax revenues expands with its base. However, because the effective tax rate is \( \rho \tau \), the peak tax revenue decreases accordingly. We can therefore predict that countries with a large share of underground - or undeclared - economic activities will have a low parameter value \( \rho \). Their potential tax base expands, or is larger than these with a small underground sector. As a result, the peak tax rate shifts to the right, but at the same time, the effective tax rate \( \rho \tau \) depresses the Laffer curve. Consequently, the peak tax rate yields comparatively lower peak revenues.

Notwithstanding the high elasticity of labour supply to taxes, median and mean values for parameter \( \phi \) we have computed for each category group do not differ significantly from these of the benchmark High-income group. In other words, parameter \( \phi \) rarely differs significantly among groups of developing and emerging economies relative to developed ones. As a result, we conclude that the elasticity effect is not high enough among the former group of countries to neutralise the tax effect \( \rho \tau \). Regardless, values for parameter \( \rho \) can contribute significantly to reduce the gap in peak revenues between High-income and other developing and emerging economies. The counter-intuitive results of the baseline are likely to be reversed for small values of that parameter.

Figure 3.9 compares the model extension for developing and emerging economies against their benchmark, the baseline Laffer curve for developed economies, as represented by their proxy of the High-income country group. The figure shows substantial improvements on the baseline model, where income groups with significant counter-intuitive results have reversed or bridged their gap with the High-income group benchmark.

Figure 3.9: Median Laffer curve for capital and labour taxes - full and incomplete access to the tax base. Income groups - World Bank Atlas method.

Figure 3.9 above compares the median Laffer curve for each income category in its baseline and extension models against the baseline High-income category group. The figure shows that for all income groups, there is a uniform trend of lower peak revenues for capital and labour. With respect to labour taxes, there is a steep decline in peak revenues with respect to the
baseline model. By comparison however, peak tax rates differ significantly across income groups. Differences in values for parameter $p$ affect both the shape of the Laffer curve as well as its peak rate. Low- and Middle-low income countries see their peak rates shift to the right, which implies a dominant effect of parameter $p$. Namely, that these countries have comparatively very low shares of declared or taxable economic activities. By contrast, Middle-high income countries shift their peak labour tax rate to the right, which means that there is a large tax base effect. In all cases however, the strongly dominant effect remains the effective tax rate $\rho \tau$ which depresses the Laffer curve. For capital taxes, a similar decline is reported for all income category groups. Notice however that all income groups shift their respective peak rates to the right, which is evidence of a positive tax base effect.

This tax base effect is however still dominated by the effective tax rate $\rho \tau$, since all Laffer curves are depressed. As far as the income-based comparison goes, the model extension contributes significantly to reduce the discrepancies in peak revenues between High-income countries and the other proxies for developing and emerging ones. Differences in parameter values and steady-state variables in developing and emerging economies create a larger tax base in comparison with developed ones. With the model extension, partial access to the tax base dominates over the counter-intuitive results and reduces their respective Laffer curves. Similar dynamics are reported for regional groups. We fit countries in our sample set into regional groups, whose respective median Laffer curves are compared against the High-income benchmark group. Figure 3.10 reports median Laffer curves for regional groups under baseline and extension models. Each regional group is compared against the High-income baseline median Laffer curve. Just as in the income-based comparison, regional groups all exhibit a decline of varying degrees in their respective Laffer curves. Similarly, peak rates have shifted in both sides with respect to the baseline. For instance, countries in Eastern Europe, the Balkans & Central Asia see their median peak rate shifts to the left with respect to their baseline curve. This is also true for Latin America & Caribbean, as well as MENA regional groups. By contrast, countries in South Asia see their median peak tax rate shift right, which suggests a large and positive effect on the tax base. For Sub-Saharan Africa however, the median peak rate does not change significantly. Differences in shifts of the labour tax peak rate are due to the impact of parameter $\rho$, and how it expands the tax base thanks to a lower wedge effect.

As reported in the previous section, developed economies are proxied by the High-income
category group and exhibit high values for parameter $\rho$. The cross-group mean differences are significant enough to attribute the changes in Laffer curve shapes to the size of undeclared/untaxed economic activities relative to output.

Figure 3.11: Whiskerplot distribution of parameter $p$ per income and region category groups. Sample set of 132 countries.

As mentioned previously in tables 3.15 through 3.6, parameter $\rho$ in High-income countries exhibits a statistically significant difference with respect to other income and regional groups. Nevertheless, some categories are not that far off from the High-income group. Although the differences are statistically significant, ANOVA results in tables 3.15 and 3.6 in particular show only a moderate gap in mean-group value for parameter $\rho$ between the benchmark group and specific group categories. In particular, we notice that there are slight differences in mean-group between High and Middle-High income groups, as well as South Asia & Pacific and MENA for the region-based category. The lack of large differences between High-income and other group categories explains why the Laffer curve for capital taxes is still counterintuitive for the Middle-High income group, as well as MENA and South Asia & Pacific. These two regional groups still offer counter-intuitive results with respect to the Laffer curve in High-income countries, albeit at a much lower degree, as reported in figure 3.12.

Figure 3.12: Median Laffer capital tax curves. Sample set broken down into regional groups.
The income-based comparison of the Laffer capital tax curve has shown that there are shifts in both ways for the extension model. We observe a similar trend for region-based comparison. There is a uniform decline in peak tax revenues for regional groups with respect to the baseline, though at varying degrees. The median countries in Eastern Europe & Balkans, Latin America and to a lesser degree Sub-Sahara Africa see their respective peak tax rates shift to the left in the extension model. It means that the tax rate effect has been large enough to depress the tax base, even though it expands thanks to a smaller wedge effect. these are all country groups with significantly lower mean-group values for parameter $\rho$, hence the dramatic shift in peak revenues and tax rates. By contrast, country groups with comparatively high mean-group values for $\rho$ see their median peak tax rate shift to the right. This is due to the fact that there was a comparatively low tax base effect. After all, their median values for $\rho$ are close to the High-income group, and they stand to gain little in terms of tax base expansion. As a result, the decline is less pronounced, and their respective Laffer curves remain counter-intuitive in their peak revenues.

**Tax collection costs and inefficiencies**

In depicting the interactions between the tax rate set by the government and its impact on its tax base, the baseline model assumes that there are no frictions in tax collection. In other words, tax authorities collect revenues as expected, whether they have full access to the tax base or not. In the second extension of the baseline model, we have assumed that the government faces a quadratic cost $\kappa$ when it sets the tax rate. As a result, tax authorities need to raise $\tau(1 + \kappa \partial \tau)$ instead, in order to make up for losses due to the collection cost. Figure 3.13 plots median Laffer curves for labour and capital taxes. It compares the benchmark case against the two extensions discussed in this section.

![Figure 3.13: Median Laffer curve for capital and labour taxes - baseline vs model extensions. Medians are computed for the sample set of 152 countries for the baseline, 132 for the first extension, and 127 for the second.](image)

The second extension model yields adverse results with respect to the baseline. Collection costs generate a decline in the tax base as well as the tax revenues. Because the government loses a fraction of its revenues, they need to set a higher rate than in the baseline model. As a result, there is a larger wedge effect that adversely affects the tax base. Consequently, they need to set their tax rate higher to extract the same level of revenues. This means that the government sets taxes at higher effective rates than the baseline, shrinking the tax base in the process. The collection cost affects the Laffer curve on both aspects of peak rate and revenues: first, the peak tax rate declines due to the shrinking tax base brought about by the larger wedge effect. Second, the shrinking tax base means that the government cannot extract as much revenue as it expects. The Laffer curve therefore shifts to the left, and is depressed with respect to the baseline curve.
The income-based category groups show that there are still counter-intuitive results with respect to the High-income country group benchmark. The second extension with collection cost $\kappa$ does not predict a different outcome with respect to the counter-intuitive results of the baseline model. Nevertheless, the model alteration shows an important result, where almost all country category groups see their Laffer curves shift to the left and slightly depressed in comparison with the baseline model. It reflects the impact of collection costs attached to signs of an inefficient fiscal system, a feature more common among developing and emerging economies. Although Middle-High income countries see no significant changes with respect to their median labour Laffer peak tax rate, the slope becomes slightly steeper on the slippery side, nevertheless. Although the same counter-intuitive results remain, we do observe that the collection cost $\kappa$ affects the peak tax rate, and generates a steeper slope for rates beyond the peak. These observations are reported in figure 3.14.

![Figure 3.14: Median Laffer curve for capital and labour taxes - collection cost $\kappa$. Income groups - World Bank Atlas method.](image)

The differences between the baseline and extension models are significant enough to conclude to the importance of tax collection costs in developing and emerging economies. The extension model isolates the effects of an inefficient tax system in order to show its effects, regardless of the size of underground economic activities in GDP. We have shown that developing and emerging economies exhibit higher mean-group values for parameter \(\kappa\)pa than developed countries. As a result, the effects of tax collection costs are more significant in the former group, and reflect adversely on their ability to extract tax revenues. Figures 3.14, 3.15 and 3.16 show that compared to High-income countries, developing and emerging economies extract fewer revenues with lower peak tax rates, regardless of the counter-intuitive outcome.

Figure 3.16 shows that the capital Laffer curve is quite sensitive to collection cost $\kappa$. Some regions, like South-Asia and the Pacific exhibit significant changes in the median capital Laffer curve, as it declines both in terms of peak tax rate and revenues with respect to its baseline shape. All other regional groups exhibit a decline in their respective median peak rates. The downward side slope of their respective curves becomes steeper due to the introduction of tax collection costs.

This extension affects the Laffer curve in a different manner compared to the first extension model. In this configuration, tax collection cost $\kappa$ brings about only the tax base effect in altering the baseline Laffer curve shape. Because the government needs to set higher tax rates in order to raise the same level of tax revenues, the wedge effect incorporated in the baseline model increases, which has a shrinking effect on the tax base. As a result, the curve shifts left, and for a high enough value for $\kappa$, it is depressed. A secondary effect of the collection cost is a
Figure 3.15: Median Laffer labour tax curves. Sample set broken down into regional groups.

Figure 3.16: Median Laffer capital tax curves. Sample set broken down into regional groups.

steeper downward slope for the Laffer curve, which suggests that tax revenues decline even more rapidly because of tax collection costs. In comparison with the first extension model, the second one does little to reduce the gap in Laffer curves between developing and emerging economies on the one side, and developed ones on the other. Nevertheless, the main takeaway is that tax collection costs are high enough in the former due to their tax inefficiencies that they shift their respective Laffer curves significantly. The combination of the two extensions into a third model gives more insight into what the Laffer curve may look like in developing and emerging economies.

Tax authorities also resort to taxing consumption in order to raise revenues. In contrast to capital and labour, governments can put significantly larger taxes on consumption. With an excise tax for instance, authorities can set tax rates larger than unity, though they do not have a marginal effect on the household consumption optimisation programme. Nevertheless, the tax
wedge effect still distorts consumption at the steady-state, and peak rates can be computed for the baseline and its two extensions.

The Consumption tax Laffer curve

Contrary to labour and capital, household consumption is not a shrinking tax base. In other words, the household does not shift its consumption away to non-market activities when the tax rate is set beyond its peak. This conclusion shared in Trabandt and Uhlig [2011, 2012] stipulates that the consumption tax can in fact be set above 100% and still yield increasing revenues. Such a result is however predicated on the assumption that the labour tax rate is set at zero. This is not realistic nor logical with respect to the household’s optimisation programme and the existence of the tax wedge. Instead, when the income tax is also varied, we obtain a similar Laffer-shaped curve with a peak rate. By comparison to labour and capital, the peak rate is higher for the baseline and extension models.

![Figure 3.17](image)

Figure 3.17: Median Laffer consumption curve: Sample-wide, High-income and other countries.

Figure 3.17 compares the consumption tax Laffer curves across all three specifications. It compares the sample-wide median against High-income and other countries. In this graph, we use High-income countries as a proxy for developed economies, while the remaining countries are consolidated into a proxy for developing and emerging economies. In all three specifications, High-income countries exhibit the highest peak revenues. The baseline model predicts also that the proxy for developed countries exhibit a higher peak tax rate. The consumption Laffer curve exhibits similar properties in changing between the baseline and the two extensions in this paper/chapter. Recall that with partial access to the tax base, there are two contradictory effects on the Laffer curve.

Access to share $\rho$ of the tax base means that the tax wedge is lower, thus having a positive impact and expending it. On the other hand, because the government can tax only a fraction $\rho$, this negates the tax base effect. As a result, the peak rate is higher in the extension model in comparison with the baseline, while lowering the peak revenue consecutively. The region-based comparison depicted in figure 3.18 yields more comprehensive results. For almost all regional groups, the peak tax rate increases between the baseline and the extension with collection cost $\kappa$. The differences were low for regional groups like the benchmark High-income countries and South Asia & the Pacific. The peak tax rates differ more significantly for regional groups like MENA and countries in Central Europe, Balkans & Central Asia.

In comparison with capital and labour, there are substantial gains to be made from taxing consumption. First, peak revenues are higher in comparison to the two other tax bases. Second, the peak rate is also comparatively higher. This is due to the fact that the Laffer curve is determined by the CRRA elasticity of substitution - whose inverse makes sure that consumption is quite inelastic to changes in the tax rate. As a result, tax authorities can extract significantly more revenues out of household consumption.

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As we have established the dynamics of Laffer tax curves for capital, labour and consumption taxes, we have identified the differences between category groups built out of our country sample. In particular, the shape and peak values for tax rate and revenues are shown to be function of structural parameter values and steady-state variables. In comparing peak rates and steady-state values computed from the dataset, we are able to assess whether a given country - or country group- is below or beyond its peak value. The distance allows us to compute the tax gains (or losses) from a tax cut. The Laffer curve predicts increasing gains when the tax rate is set beyond its peak value. In this case, any reduction in the steady-state tax rate is bound to generate additional revenues. If the steady-state tax rate is below its peak value, then a further tax cut is likely to reduce tax revenues, though not at a commensurate rate. Indeed, the tax revenue loss due to the reduction in the tax rate is partially offset by the expanding tax base due to the lower tax wedge effect. The offset is referred to as the share of self-financed tax cut, i.e. the percentage of tax losses for which the expanding base makes up.

**Self-financed tax cuts**

One of the main contentions of the Laffer curve is that a tax cut is fully self-financed when the tax rate is set beyond its peak rate. In other words, for excessively high levels of taxation, cutting taxes actually increases tax revenues. The converse of this assertion is that when the tax rate is below its peak value, it is only partially funded. However, note that the close the tax rate is to its peak value, the higher the fraction of self-financed tax cut. Table 3.10 below reports the median values for self-financed tax cuts when the rate is lowered by one percentage point. The self-financed tax cut is computed as the ratio of revenue loss due to the decline in tax rate relative to the gains in expanding tax base.

The baseline model suggests that the median tax cut of 1% varies across tax bases. Self-financed tax cuts are highest for consumption taxes at 96.7% for the baseline and second extension models. This means that a tax cut of 1% in the consumption rate is likely to be almost fully funded. The same argument applies with a tax increase of 1% in consumption tax rate will yield almost the same in revenues. The self-funded tax cut increases slightly to 98% under the partial access to the tax base extension model. Labour taxes are also highly self-funded when they are cut around the steady-state value - with 93.1% and 93.2% for the baseline and second extension models. The self-financed cut increases to 95.6% under the first model extension. Finally, capita tax cuts are the least self-funded, with values ranging from 68 to 85% between the three model specifications. We report these differences for relatively low benefits from at
capital tax cut because most countries are far away from their peak rate values. The median peak value for the sample set for capital tax rates is 34% to 33% should be compared against the median value of steady-state capital tax rate of 19.56%.

Table 3.10: Median values for a self-financed tax cut of 1%.

<table>
<thead>
<tr>
<th>Tax</th>
<th>Median Baseline</th>
<th>ρ</th>
<th>share cost κ</th>
</tr>
</thead>
<tbody>
<tr>
<td>τ^c</td>
<td>9.23%</td>
<td>97.94</td>
<td>96.61</td>
</tr>
<tr>
<td>τ^n</td>
<td>8.30%</td>
<td>96.66</td>
<td>93.22</td>
</tr>
<tr>
<td>τ^k</td>
<td>19.56%</td>
<td>68.27</td>
<td>68.54</td>
</tr>
</tbody>
</table>

Note: The self-financed tax cut is computed as the elasticity of tax revenues to changes in the tax rate in the neighborhood of its steady-state value. The table reports median values for each country in the sample set.

It is worthwhile to point out the higher gains from a tax cut in the first extension model with respect to the baseline and second extension. Under partial access to the tax base, the tax burden is higher on declared/taxed economic activities - in this case, capital returns. In contrast with the baseline, a tax cut does not affect the whole tax base when the government has a partial access to it. In addition, because of the tax base effect mentioned in the previous section, the peak rate is comparatively higher under the first extension model. The combination of the two explanations can account for the low level of self-funding in a corporate tax cut. The tax cuts effects vary across countries for two reasons: first, there are different values for structural parameters and steady-state variables. This is critical because the analytical expressions for peak tax rates for all three tax bases are function of these parameters. Second, the steady-state tax rates for each country may be close to the implied peak rates of their respective Laffer curves. Some countries may be close or past their peak rates, which means that tax cuts are fully self-funded, or generate additional revenues. Others are well below their peak rates, so self-financed cuts are not as large. In order to compare the effects of tax cuts and the magnitude of their self-funding, we compute the median self-financed tax cut for each income group using the World Bank Atlas method. Table 3.11 reports median self-financed tax cuts. We use the High-income category as a benchmark and the other income groups as proxies for developed and emerging economies.

Table 3.11: Median values for a self-financed tax cut of 1% - income group.

<table>
<thead>
<tr>
<th>Income group</th>
<th>Consumption tax τ^c</th>
<th>Labour tax τ^n</th>
<th>Capital tax τ^k</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Income</td>
<td>Baseline 97.33</td>
<td>Baseline 87.38</td>
<td>Baseline 76.64</td>
</tr>
<tr>
<td></td>
<td>ρ share 98.13</td>
<td>p share 91.78</td>
<td>p share 89.93</td>
</tr>
<tr>
<td></td>
<td>cost κ 97.31</td>
<td>cost κ 86.82</td>
<td>cost κ 74.42</td>
</tr>
<tr>
<td>Middle Low</td>
<td>96.33</td>
<td>96.48</td>
<td>72.67</td>
</tr>
<tr>
<td></td>
<td>96.93</td>
<td>95.94</td>
<td>87.58</td>
</tr>
<tr>
<td></td>
<td>96.27</td>
<td>96.49</td>
<td>73.09</td>
</tr>
<tr>
<td>Middle High</td>
<td>95.76</td>
<td>93.08</td>
<td>68.29</td>
</tr>
<tr>
<td></td>
<td>97.35</td>
<td>93.76</td>
<td>84.33</td>
</tr>
<tr>
<td></td>
<td>95.68</td>
<td>93.22</td>
<td>70.65</td>
</tr>
<tr>
<td>High Income</td>
<td>96.61</td>
<td>96.32</td>
<td>65.45</td>
</tr>
<tr>
<td></td>
<td>96.55</td>
<td>95.32</td>
<td>77.24</td>
</tr>
<tr>
<td></td>
<td>96.57</td>
<td>93.48</td>
<td>66.87</td>
</tr>
<tr>
<td>Others</td>
<td>96.76</td>
<td>93.70</td>
<td>71.97</td>
</tr>
<tr>
<td></td>
<td>97.82</td>
<td>93.00</td>
<td>87.58</td>
</tr>
<tr>
<td></td>
<td>96.67</td>
<td>93.00</td>
<td>71.95</td>
</tr>
</tbody>
</table>

Note: Median self-financed tax cut. Income group category groups, World Bank Atlas method. The percentage of self-financed tax cut is computed as the elasticity of tax revenues to changes in the tax rate in the neighborhood of its steady-state value. 'Others' category refers to non-High income countries in the sample set.
Although all income groups exhibit high median self-financed tax cuts for consumption taxes, there are significant differences between model versions. First, the percentage of self-funding increases between the baseline and the first model extension for all income groups except for the High-income category. We explain this with the fact that the benchmark group exhibits a high level of declared tax base. As a result, proxies for developing and emerging economies show that a tax cut is more self-funded thanks to the tax base effect described in the previous sections.

Table 3.12: Median values for a self-financed tax cut of 1% - income group.

<table>
<thead>
<tr>
<th>Region</th>
<th>Consumption tax $\tau^c$</th>
<th>Labour tax $\tau^n$</th>
<th>Capital tax $\tau^k$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline p share</td>
<td>cost $\kappa$</td>
<td>Baseline p share</td>
</tr>
<tr>
<td>Hi-Income</td>
<td>96.61% 96.61% 95.57%</td>
<td>93.61% 95.32% 93.48%</td>
<td>65.45% 77.24% 66.87%</td>
</tr>
<tr>
<td>CEEBCA</td>
<td>93.93% 96.71% 93.85%</td>
<td>90.76% 92.11% 92.29%</td>
<td>85.35% 93.91% 85.21%</td>
</tr>
<tr>
<td>LATCAB</td>
<td>95.68% 96.86% 95.67%</td>
<td>93.06% 93.65% 93.09%</td>
<td>71.97% 88.31% 70.65%</td>
</tr>
<tr>
<td>MENA</td>
<td>97.52% 98.34% 97.49%</td>
<td>88.51% 92.12% 89.56%</td>
<td>59.39% 77.95% 57.54%</td>
</tr>
<tr>
<td>SEAPAC</td>
<td>97.89% 98.38% 97.86%</td>
<td>98.35% 98.13% 98.34%</td>
<td>74.91% 82.75% 75.45%</td>
</tr>
<tr>
<td>SUBSAF</td>
<td>96.81% 97.74% 96.74%</td>
<td>90.55% 91.78% 90.22%</td>
<td>64.02% 86.85% 62.56%</td>
</tr>
</tbody>
</table>

Note: Median self-financed tax cut. Income group category groups, World Bank Atlas method. The percentage of self-financed tax cut is computed as the elasticity of tax revenues to changes in the tax rate in the neighbourhood of its steady-state value.


The consistency of consumption taxes is not observed for labour taxes however. Although the percentage of self-funding tax cut larger in the first extension model, Middle-low income countries see their median self-financed tax cut drops from 96.5% to 96% between the baseline and the first extension models. Capital taxes are the least self-financed in the three tax bases of the model. This is due to the fact that most effective corporate tax rates are far away from their respective peak values. As a result, taxes are less self-funded, and there is little gain from cutting the corporate tax rate. In the baseline model, the median self-funded capital tax cut for High-income countries is 64.5% whereas that number is higher at 72% for others, proxies for developing and emerging countries. The baseline predictions are moderate in comparison with the first model extension, respectively at 77% and 87.6%.

We extend the same analysis to the regional groups built as proxies for developing and emerging economies. Table 3.12 above reports the median values for self-financed tax cuts for each regional group and compared against the proxy for developed economies, the High-income category group. Self-funding for a consumption tax cut is high and close to one across the board. There are slight variations in comparing the baseline model against its two extensions. Emerging economies continue to exhibit higher self-funding for a tax cut in the first extension model. Because the share of underground economic activities in GDP is higher among developing and emerging economies, a tax cut benefits the consumption tax base on two counts: first, a tax cut reduces the size of its wedge effect on its base. Second, the tax cut effect dominates, which explains why the self-funding is not at unity or above. The distortion introduced by parameter $\rho$ is lower in developed countries, which is why self-funding for a tax cut declines for the benchmark group between the baseline and first extension models.

This is not the case for labour taxes, however. All regional groups see their self-funding share of a tax cut increase from the baseline to the extension with partial access to the tax base, except one. The median country in South Asia & the Pacific exhibit a slight decline in its self-financed tax cut. This can be accounted for by looking at figure 3.10. The baseline model predicts a lower peak rate in comparison to the extension with partial access $\rho$ to the tax base. A lower peak rate means that there is a smaller distance with the steady-state rate, and thus
greater gains from a tax cut. In the case of countries in South Asia, the baseline model predicts a lower peak rate in comparison with the first extension. This means that tax cut gains would be higher for the baseline model, thus the slight decline for this regional group. The tax cost effect of the second extension model is different across tax bases: the consumption tax cut sees its self-financed share slightly declines for all regional groups, regardless of level of income. This is not the case for the income tax, however. Countries with a high collection cost \(\kappa\) see the most gains from a labour tax cut. This is the case because when tax authorities scale back their rate, the wedge effect on labour supply declines. As a result, the gains from an expanding tax base are large enough to almost pay entirely for the tax reduction.

Capital tax cuts are the least likely to self-fund at a large percentage. The baseline model and its second extension predict relatively low levels of self-funding, ranging from 62% for Sub-Saharan Africa to 85% for Central Europe & Central Asia. We have explained before that median steady-state capital tax rates are low across the board and quite far from the peak rate values computed in the baseline model. Such an explanation is weakened for the first extension model. As mentioned before, under partial access to the tax base, a tax cut boosts the base because it weakens further the wedge effect of taxation. In the case of capital, the gains from a smaller wedge are large enough to increase significantly the percentage of self-finance for a capital tax cut. The distribution of such gains is not homogenous across regional groups however. Countries with the smallest share of self-funding tax cut are the ones benefitting the most: the median country in Sub-Sahara Africa sees the percentage of its self-financing share from 62-64% to 86.85%. This is the case because the region has one of the lowest shares of declared and/or taxable economic activities in GDP. This is also the case for MENA countries, where the median sees a capital tax cut increase its self-funding from 57-60% to 78% when the percentage of taxable/declared activities is taken into account. High-income countries increase their share of self-funding for a corporate tax cut, but not as much as developing economies. We explain this results by the fact that these countries have an efficient fiscal system, so parameter \(\rho\) is already close to unity. Second, the gains from a smaller tax wedge are not large enough to generate the virtuous effect of an expanding tax base. As a result, the percentage of self-funding for a tax cut we compute for High-income countries is between 67% and 77%, a figure closer to findings in the literature, e.g. [Mankiw and Weinzierl 2006].

Figure 3.19 below reports the Laffer curves for all three tax bases under the three specifications of our model: baseline, partial access to the tax base and tax collection costs.

The figure plots the median Laffer curves for the whole sample, High-income and other developing and emerging economies. It also plots the median steady-state values of tax rates and revenues for each country in the sample set. The figure uses the two sub-categories to stylise developed countries (High-income) and the remaining items in the sample set (developing and emerging). We use throughout this paper the High-income country group as a proxy for developed economies, while the remaining countries in our sample set are considered to be developing and emerging. In comparing the Laffer curves for each tax base between the two sub-categories, figure 3.19 shows that self-funding for tax cuts changes substantially from the baseline to the first extension model. The partial access of \(\rho\) share in the tax base alters significantly the tax peak rate, and as a result the distance with the observed steady-state tax rate affects the percentage of self-funding for a tax cut. It is also sensitive to the curvature of the revenue functions. Because the curve is usually flatter for the first extension model, there are higher gains to be made from a tax cut, even if the steady-state tax rate is far from its peak value. This explains why High-income countries can still improve the percentage of self-funding of their capital tax cut, even though it is far from its peak value. Although a tax cut is desirable in all three cases given the high percentage of self-funding, the gains are uneven. Indeed, it appears that capital tax cuts, which are frequently touted as a necessary policy to boost capital accumulation, appear to exhibit the lowest percentage of self-finance. This is due to the fact that most countries in our sample set have considerably reduced their respective corporate rates.
over the last couple of decades. This means that there is little room from tax base gains when the government reduces further their capital tax rates. By contrast, consumption tax rates are considerably low in comparison with their peak values, which suggests room for funding the shortfall in tax cuts for labour and/or capital.

For developing and emerging economies however, the challenge lies beyond changes in the tax rate and its self-funding share. The first extension of the baseline appears to be a more realistic representation of the limitations facing tax authorities in these countries. The fact that the government can only tax a fraction of its base generates a paradoxical result: on the one hand, the underground economy is freed from the tax wedge, and expands its base as a result. On the other hand, the tax burden falls more heavily on declared activities, which does not translate into higher tax revenues for the government as a result. Developing and emerging economies stand to benefit significantly from increasing their value of parameter $\rho$, namely the share of declared/taxable economic activities. Following the summary results reported in figure 3.19, they can more than double tax revenues while at the same time reduce the peak rate of their taxes on capital and labour. There are also positive gains from consumption taxes, though in this case a tax increase is more profitable since consumption is easier to tax via value-added taxes, for instance. Another avenue that governments in developing and emerging economies may find interesting to explore is the cost of tax collection. There are substantial losses recorded in collecting taxes as expressed in parameter $\kappa$. We have shown earlier that although there are no significant changes with respect to the baseline, the tax collection model introduces two important features that weaken tax authorities ability to collect revenues. Collection cost $\kappa$ shifts the Laffer curve slightly to the left, which means that the peak revenue declines, even if slightly. Furthermore, the curve also is slightly depressed, which means that tax authorities also lose revenues in the process. Another feature that is important to the Laffer predictions is that the slope curve becomes steeper past the peak rate. In other words, revenue losses from tax increases are larger the higher the tax rate. This means that collection costs become crippling when tax authorities set their tax rate beyond its peak value. In this instance, there are gains to be made from reducing the gap between overall tax burden and the sum base-specific revenues.
The inefficiencies may be due to inadequate legislation, or choices made by policymakers that exacerbate the distortionary effects of taxation on its sources of revenues.

To sum up, the Laffer curve is an adequate tool to assess how far developing and emerging economies are from their respective peak rates. Although the majority have not reached it yet, they are hampered by other factors in increasing their tax revenues. The importance of underground economic activities, as illustrated by the partial access $\rho$ to the tax base has been relevant to the size of undeclared and/or untaxable economic sectors relative to GDP. Thanks to the first model extension, the Laffer curve is more relevant to the specifics of developing and emerging economies and their inability to increase tax rates and revenues without reaching their peak values. Tax collection costs also contribute to skew tax revenues downward and to the left, reflecting the revenue losses that tax authorities need to make up for by increasing taxe rates even higher.

3.5 Conclusions

Our paper/chapter contributes to the literature on the Laffer curve by applying it to emerging and developing countries. Using the model developed in Trabandt and Uhlig [2011, 2012] we argue that the Laffer curve is sensitive to two factors, namely the size of underground economic activities and tax collection costs. More specifically, relative to Trabandt & Uhlig, we assume that household utility function is separable in labour and consumption. This alteration is motivated by the fact that there is no cross-elasticity between consumption and worked hours. Furthermore, empirical evidence shows that households in developing and emerging economies face the extensive, rather than intensive margin. In other words, the labour supply choice is between working and not working, rather than in volume of worked hours. This alters significantly the dynamics of the household optimisation programme. Our model stipulates that the household maximises their utility over consumption and labour, constrained by their resources. Capital, labour and consumption are all taxed at their respective rates, which creates wedges in all three. Labour supply in particular, equates the marginal rate of substitution between consumption and labour with its marginal productivity. The equality is distorted with a wedge tax that reduces labour supply as taxes increase.

The baseline model exhibits counter-intuitive results for developing and emerging economies. The differences in Laffer curve shapes are due to the values computed for structural parameters and steady-state variables. Developing and emerging economies are more likely to exhibit higher share of consumption-to-output ratios, which means that the income effect is large enough for households to be elastic to tax changes. Labour tax revenues are also function of the Frisch elasticity, a key component given the controversy in the literature as to the range of acceptable values they may take. The same differences are reported with respect to capital tax revenues. Developing and emerging economies exhibit higher levels of real interest rate, and as a result they are likely to exhibit higher tax revenues at the peak level. Furthermore, the same set of countries also exhibits higher levels of productivity growth rates, which have a positive impact on after-tax capital stock. By contrast, consumption tax revenues are higher among developed countries. The baseline model is further extended in two directions: the first extension assumed that tax authorities do not have full access to the tax base. In other words, they would observe only a fraction $\rho$ of their tax base, and tax it accordingly. The model predicts two contradictory effects: partial access to the tax base means that the tax wedge effect is weaker than the baseline, which boosts the former. However, the government can only extract revenues at a smaller effective tax rate. Ultimately, the second effect clearly dominates, which pushes the Laffer curve downwards, while shifting the peak rate to the right. This extension has improved tremendously the model’s ability to predict the Laffer curves of developing and emerging economies with respect to developed ones. Although many of the former improve their respective peak rates, their
revenues decline accordingly, more than commensurate to the differences in values of parameter $\rho$ between the two country groups.

In the second extension, we have assumed that authorities face a different kind of limitation, in the form of tax collection costs. The government faces costs that arise from inefficiency or difficulties in identifying the tax base. Given the large values we have computed for parameter $\kappa$, developing and emerging economies face larger costs in setting their tax rates. This has the effect of shifting the Laffer curve to the right and downwards. This is due to the fact that the effective tax rate is higher than expect, and so would the tax wedge effect be on the three tax bases. As a result, the government extracts fewer revenues, and hits a comparatively smaller level of tax peak rate. It also means that the peak tax revenue would be lower as a result.

The main prediction of the Laffer curve in its original specification is that if the tax rate is set beyond its peak value, then any tax cut actually increases revenues. In other words, the reduction in tax rates is self-financed. By contrast, when the tax rate is below its peak value, a further tax cut is only partially self-financed. Two factors can have an impact on the percentage of self-funding when the tax rate is reduced: the distance of its steady-state value from the peak, and the curvature of the Laffer curve. We have found that for most countries, the peak rate is higher than its steady-state value. As a result, tax cuts do not increase revenues, but pay for themselves at higher fractions that usually reported in the literature. For consumption and labour taxes, we explain this by the fact that most countries are either at their respective peak rates and/or exhibit steep curvature that increase self-funding when tax rates are cut. Results are more nuanced for capital taxes, which exhibit the lowest percentage of self-finance. We have explained this by the fact that most countries have engaged in steady reduction of their respective corporate rates. As a result, the steady-state tax rates are much lower than their peak values, and there are comparatively little gains from further tax cuts. As a result, should governments in developing and emerging economies seek to reduce their overall tax burden and boost their tax bases, they would do well to chose a specific combination of tax cuts and increases that would maximise revenues without too much distortion.

In the two extensions, the model offers alternative sets of policies for tax authorities in developing and emerging economies to improve their tax revenues without changing their tax rates. For instance, a larger share of declared/taxable economic activities improves tax revenues without distorting significantly the tax base. Indeed, the governments of these economies can afford to cut taxes when they integrate a higher percentage of underground economic activities. Similarly, reducing tax cost collection reduces the tax wedge effect, and thus boost the tax base as a result. These policy measures are more linked to the political economy of developing and emerging economies. The integration of undeclared/untaxed economic activities, or the reduction tax collection cost call for changes in institutional arrangements, or cracking down on corruption and inefficiencies to improve tax collection. The distance between steady-state tax rates and their peak values would therefore be function of institutional quality indicators, with the more advanced economies bridging the gap at a faster rate than these with institutions of lesser quality.
Bibliography


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Table 3.13: Structural parameters - average values per Freedom House status category.

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**Note:** Standard errors reported in parentheses. See comments on table 3.3. Summary statistics are computed for sub-categories.
Table 3.14: Structural parameters - average values per region group category.

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**Note:** Standard errors reported in parentheses. See comments on table 3.3. Summary statistics are computed for sub-categories.
Table 3.15: Structural parameters - ANOVA regression results, G7 as group base level

<table>
<thead>
<tr>
<th>Variable</th>
<th>$\beta$</th>
<th>$\delta$</th>
<th>$\alpha$</th>
<th>$\sigma$</th>
<th>$\phi$</th>
<th>$\rho$</th>
<th>$\kappa$</th>
</tr>
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<tr>
<td>No G7/OECD</td>
<td>-0.042**</td>
<td>0.013</td>
<td>-0.036</td>
<td>0.943</td>
<td>0.229</td>
<td>-0.224**</td>
<td>-0.02</td>
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<td>(0.021)</td>
<td>(0.009)</td>
<td>(0.085)</td>
<td>(0.805)</td>
<td>(0.248)</td>
<td>(0.044)</td>
<td>(0.12)</td>
</tr>
<tr>
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<td>0.011</td>
<td>-0.033</td>
<td>0.038</td>
<td>0.126</td>
<td>-0.125**</td>
<td>0.14</td>
</tr>
<tr>
<td></td>
<td>(0.025)</td>
<td>(0.011)</td>
<td>(0.104)</td>
<td>(0.983)</td>
<td>(0.304)</td>
<td>(0.053)</td>
<td>(0.143)</td>
</tr>
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<td>0.001</td>
<td>-0.002</td>
<td>0.248</td>
<td>0.037</td>
<td>-0.027</td>
<td>0.131</td>
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<td>(0.01)</td>
<td>(0.098)</td>
<td>(0.928)</td>
<td>(0.287)</td>
<td>(0.05)</td>
<td>(0.133)</td>
</tr>
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<td>0.017**</td>
<td>0.342**</td>
<td>1.959**</td>
<td>0.189*</td>
<td>0.846***</td>
<td>-0.369***</td>
</tr>
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<td>(0.02)</td>
<td>(0.008)</td>
<td>(0.083)</td>
<td>(0.781)</td>
<td>(0.108)</td>
<td>(0.042)</td>
<td>(0.117)</td>
</tr>
</tbody>
</table>

| N             | 152      | 152      | 152      | 152      | 152    | 132     | 127      |
| R2 Adjusted   | 0.044    | 0.017    | -0.017   | 0.009    | -0.006 | 0.331   | 0.033    |
| RMSE          | 0.053    | 0.022    | 0.219    | 2.067    | 0.638  | 0.112   | 0.261    |
| RSS           | 0.422    | 0.074    | 7.086    | 632.623  | 60.302 | 1.594   | 8.385    |
| Fisher        | 3.308    | 1.868    | 0.163    | 1.452    | 0.72   | 22.571  | 2.446    |

**Note:** Available data for 132 countries for $\rho$, 127 countries for $\kappa$. Standard errors are reported in parentheses. Level of significance is denoted with stars. Legend: * < 1%. ** 5% and * 10%. Intercept reports G7 mean group and level of significance. Estimated coefficients report differences in mean groups.

Table 3.16: Structural parameters - ANOVA regression results, High Income countries as group base level

<table>
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<tr>
<th>Variable</th>
<th>$\beta$</th>
<th>$\delta$</th>
<th>$\alpha$</th>
<th>$\sigma$</th>
<th>$\phi$</th>
<th>$\rho$</th>
<th>$\kappa$</th>
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<td>-0.031***</td>
<td>0.009*</td>
<td>-0.045</td>
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<td>0.029</td>
<td>-0.157**</td>
<td>-0.142**</td>
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<td>(0.011)</td>
<td>(0.005)</td>
<td>(0.045)</td>
<td>(0.424)</td>
<td>(0.132)</td>
<td>(0.023)</td>
<td>(0.058)</td>
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<td>-0.03***</td>
<td>0.001</td>
<td>-0.039</td>
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<td>0.152</td>
<td>-0.194***</td>
<td>-0.177***</td>
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<tr>
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<td>(0.012)</td>
<td>(0.005)</td>
<td>(0.048)</td>
<td>(0.451)</td>
<td>(0.14)</td>
<td>(0.025)</td>
<td>(0.063)</td>
</tr>
<tr>
<td>Low Income</td>
<td>-0.042***</td>
<td>0.006</td>
<td>0.017</td>
<td>1.111</td>
<td>0.218</td>
<td>-0.21***</td>
<td>-0.214***</td>
</tr>
<tr>
<td></td>
<td>(0.013)</td>
<td>(0.006)</td>
<td>(0.054)</td>
<td>(0.513)</td>
<td>(0.159)</td>
<td>(0.028)</td>
<td>(0.065)</td>
</tr>
<tr>
<td>Base</td>
<td>0.951***</td>
<td>0.024***</td>
<td>0.33***</td>
<td>2.162***</td>
<td>0.304***</td>
<td>0.782***</td>
<td>-0.242***</td>
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<td>(0.007)</td>
<td>(0.003)</td>
<td>(0.03)</td>
<td>(0.282)</td>
<td>(0.088)</td>
<td>(0.015)</td>
<td>(0.038)</td>
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</tbody>
</table>

| N             | 152      | 152      | 152      | 152      | 152    | 132     | 127      |
| R2 Adjusted   | 0.071    | 0.009    | -0.007   | 0.021    | -0.003 | 0.42    | 0.083    |
| RMSE          | 0.053    | 0.022    | 0.218    | 2.054    | 0.637  | 0.104   | 0.254    |
| RSS           | 0.41     | 0.074    | 7.018    | 624.647  | 60.12  | 1.381   | 7.954    |
| Fisher        | 4.832    | 1.482    | 0.641    | 2.1      | 0.871  | 32.671  | 4.8      |

**Notes:** Available data for 132 countries for $\rho$, 127 countries for $\kappa$. Standard errors are reported in parentheses. Level of significance is denoted with stars. Legend: * < 1%. ** 5% and * 10%. Intercept reports High-income countries mean group and level of significance. Estimated coefficients report differences in mean groups.
Table 3.17: Calibrated values - whole sample.

<table>
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<tr>
<th>ISO</th>
<th>Country</th>
<th>( \beta )</th>
<th>( \delta )</th>
<th>( \alpha )</th>
<th>( \sigma )</th>
<th>( \phi )</th>
<th>( \rho )</th>
<th>( \kappa )</th>
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<td>Angola</td>
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<td>0.022</td>
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<td>0.006</td>
<td>0.396</td>
<td>1.291</td>
<td>0.814</td>
<td>0.637</td>
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<td>United Arab Emirates</td>
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<td>0.731</td>
<td>0.09</td>
</tr>
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<td>Argentina</td>
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<td>0.745</td>
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<td>0.053</td>
<td>0.494</td>
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<td>2.541</td>
<td>0.513</td>
<td>-0.256</td>
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**Notes:** Available data for 132 countries for $\rho$, 127 countries for $\kappa$. 

122
Table 3.20: Calibrated values - whole sample.

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<th>ISO</th>
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<th>(\delta)</th>
<th>(\alpha)</th>
<th>(\sigma)</th>
<th>(\phi)</th>
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Notes: Available data for 132 countries for \(\rho\), 127 countries for \(\kappa\).
Chapter 4

The New Phillips Equation in a Small Open Economy
The New Phillips Equation in a Small Open Economy

**Abstract**

The New Phillips equation establishes a link between present inflation and expected fluctuations of the average marginal cost. In an open economy environment it becomes sensitive to openness to trade, and frictions that may arise from it. We show that when trade costs, in the form of an iceberg cost are incorporated, domestic price stickiness decreases, as domestic firms focus on tracking their average marginal cost for their pricing schedule. Furthermore, when the elasticity of substitution between domestic and imported goods generates strategic interaction effects that divorce domestic prices from their marginal costs. Nevertheless, for low enough values of elasticity of substitution, the competitive effect dominates, and domestic prices track closely the output gap. We use a sample set of 152 countries, which are combined into category groups with proxies for developed and emerging economies to simulate the predictions made in the model. Using the calibrated values for individual countries in our sample set, we show that domestic price stickiness is lowest in emerging economies, in comparison with advanced ones. This result contrast with the opposite effect of trade costs, as their decline increases price stickiness. Given the downward trend in dismantling trade costs, a lower elasticity between domestic and imported goods would contribute to keep price stickiness at low levels in emerging economies.

*JEL Codes: F12, F41, E52.*

This paper/chapter has been presented in an earlier version titled *Microfoundations of the New Keynesian Phillips Curve in an Open Emerging Economy*. The author would like to thank for their comments and remarks Jean-Pierre Allegret, Cécile Couharde, Sophie Guillonx-Nefussi, Lise Patureau, Fabien Tripier, Thepthida Sopraseuth and Ludovic Julien. Pauline Gandré is also thanked for her comments and help at the PhD Seminar at EconomiX Paris Nanterre. The author gratefully acknowledged participants and their feedback at the following conferences: The VIII SIGE Workshop at Paris Nanterre University (November 2016). The 66th annual AFSE conference at Nice, France (June 2017). The 2018 T2M Conference at Paris Dauphine University, France (March 2018) and the 2018 Royal Economic Society at Sussex, United Kingdom (March 2018).

**Bernard:** I don’t think Sir Humphrey understands economics, Prime Minister; he did read Classics, you know.

**Hacker:** What about Sir Frank? He’s head of the Treasury!

**Bernard:** Well I’m afraid he’s at an even greater disadvantage in understanding economics: he’s an economist.

---

Yes, Prime Minister - *A Real Partnership*
Introduction

The [Phillips 1958] has undergone various changes since it was first formulated in order to account for the relationship between unemployment and inflation. [Woodford 2003] reports the expression for which a clear consensus has been formed. The most recent version write inflation as a function of expected and discounted fluctuations of the average marginal cost around its steady state. A further general expression replaces the average marginal cost with the output gap. In its micro-founded formulation, the Phillips curve posits that the economy is populated with a continuum of small firms, specialising each in a single intermediate good. These firms are price-setters, and thus set their production below optimum, using their markup power. The model framework also assumes that firms cannot adjust their prices instantaneously due to random indexations, or real costs attached to price changes. The literature uses wages as a proxy for production costs, and thus considers the output gap as proportional to deviations of the average marginal cost around its competitive, flexible-prices level. As a result, inflation can be expressed as a discounted sum of future expected variations in the output gap. The New Keynesian Phillips curve (NKPC) in the canonical model writes its slope as a function of its structural parameters, and in particular the adjustment process by which firms match their prices to changes in the average marginal cost. When introduced in an open economy environment, the literature posits that the consumer has a domestic bias, which ultimately affects the Phillips equation slope. Otherwise, the main conclusions of the standard NKPC framework remain valid when incorporated in an open economy.

We adopt the canonical open-economy New Keynesian model put forward in [Gali and Monacelli 2005] with several alterations. Our paper/chapter makes use of the fact that we study small open emerging economies. As such, intermediate firms are assumed to face the same level of elasticity of substitution, regardless of their country of origin. However, the household does make a difference between aggregate domestic and imported consumption goods. We take advantage of this properties to break down the two corollaries of imperfect competition: first, intermediate firms enjoy a mark-up over their own production. This means that output is set below its competitive level, and at the aggregate level, there is a pricing schedule. Second, domestic firms face competition from imported goods, but they also take into account the fact that both are strategic complements to each other. This is the case because as the variety of intermediate goods expands, consumer welfare increases as well. This means that any pair of intermediate firms are not only competitors, but also complements to each other as their differentiated products enhance household welfare. Third, the pricing schedule takes into account not only changes in the marginal cost, but also how foreign firms price their goods. As a result, the Phillips equation slope becomes sensitive not only to the weight given by the household to their domestic consumption, but also to other aspects of trade friction, such as iceberg costs, or the elasticity of substitution effect between imported and domestic goods.

We enumerate the contributions of the paper/chapter as follows: first, we extend the notion of domestic bias beyond the result of intrinsic preferences to the household. The canonical model writes the Phillips curve as a function of this preference weighting, and writes trade indicators, such as the exchange rate or net exports as being commensurate to terms of trade, or the ratio of aggregate foreign and domestic prices. Instead, the incorporation of trade costs and elasticity of substitution allows us to write these trade variables in a more realistic fashion, which takes into account the trade frictions that small open economies face. Second, because the Phillips equation in our model incorporates these trade frictions in its slope, we establish a clear link between price stickiness on the one hand, and trade openness - or domestic bias - elasticity of substitution and trade costs on the other hand.

The paper/chapter is outlined as follows: the first section reviews the two strands of the literature the papers draws on to formulate our model, namely the New Keynesian synthesis and
New Open Economy macroeconomics literatures. The second section introduces a New Keynesian model in which we consider significant alterations with respect to the standard framework. We introduce trade frictions in the form of iceberg costs, as well as substitution effects between domestic and imported goods. The main results predicted by our model are that trade has an ambiguous effect on domestic price stickiness. On the one hand, trade costs allow domestic firms to focus on tracking their marginal costs more closely in their price-making schedule. On the other hand, a large substitution effect between imported and domestic goods raises the strategic complementarity effect. This results in higher price stickiness, since domestic firms care more about price changes in their foreign competitors, rather than their own marginal costs. The third section offers a summary, and concludes.

4.1 Literature review

The model in our paper/chapter draws upon two strands of macroeconomic literature, defined by a common thread of shared topics. The New Keynesian synthesis devotes a substantial amount of its research on commitment and credibility issues when it deals with monetary policy and its welfare effects. The open economy macroeconomics on the other hand, deals with the impact of macroeconomic policy on trade variables, such as the exchange rate, terms of trade or the trade balance, to name a few. Both incorporate market imperfections and nominal rigidities, as well as focus on inter-temporal substitution and micro-foundations. Another shared aspect is the literature’s interest in macroeconomic policy. We review in this section contributions from the literature relevant to our model.

The New Keynesian Synthesis

The New Keynesian synthesis shares with the New Open Economy macroeconomics the purpose of formulating a micro-founded framework with strong theoretical foundations. The New Keynesian synthesis focuses on two equations that are a staple of standard Keynesian models, namely the Philips curve, and the IS equation. The New Keynesian literature proceeds in two steps, first in testing its empirical robustness, and second, through a fully-fledged economic model. The preliminary step is critical in the sense that it uses empirical evidence to justify the relevance of the New Keynesian synthesis. In particular, we look at the results yielded in Fuhrer and Moore [1995] and Fuhrer [1997] for the inflation/output tradeoff, McCallum and Nelson [1999] for an optimising Investment/Savings (IS) equation with a forward-looking component, and Gali and Gertler [1999] in testing for the New Keynesian Phillips curve, with both forward and backward-looking components. In their study of the Phillips curve, Fuhrer and Moore [1995] posit that the backward-looking specification implied by the Taylor [1980] wage-contract model is not consistent with U.S. data. They propose to replace the Taylor-Phelps setting with the following expression:

\[ \pi_t = \pi_{t-1} + \gamma y_t \]  
\[ \pi_t = \frac{1}{2} (\pi_{t-1} + \mathbb{E}_t \pi_{t+1}) + \gamma \hat{y}_t \]  

Where \( \pi, y \) and \( \hat{y} \) refer respectively to inflation, output and its moving average. They also argue that the standard specification fails to replicate empirical inflation persistence, which they explain by the fact that it does not depend on parameter values and estimation, but rather the way inflation is introduced in the Phillips curve. Fuhrer and Moore [1995] conclude that the data rejects decisively the backward-looking Phillips curve, whereas their estimation results suggest that the hybrid Phillips curve, with both forward and backward-looking inflation component, is statistically more robust. This forward-looking outlook is shared in McCallum and...
whose purpose is to check if the Keynesian model can be fitted within a dynamic, optimising general equilibrium model. They formulate an IS equation with a forward-looking output component, which matches an optimising model. Their proposed model is micro-founded, for agents are defined by their economic functions. That optimising behaviour yields the forward-looking IS equation, which is derived from the log-linearised consumers’ Euler equation.

also estimate inflation dynamics in order to check on the validity of the Phillips curve. The authors develop a structural model with a hybrid Phillips curve, i.e. one with a backward-looking inflation component. They test the validity of the Phillips curve as a convex combination of future and past inflation, which writes thus:

$$\pi_t = \delta x_t + (1 - \varphi)E_t \pi_{t+1} + \varphi \pi_{t-1}$$  \hspace{1cm} (4.1.3)

Where $0 < \varphi < 1$ refers to past inflation persistence. then test for de-trended output as a proxy for the marginal cost, but find their estimation results not to be statistically significant. By contrast, when they use average real wages as a proxy for marginal costs, their estimation results are more robust, and they conclude that wages are a good proxy for marginal costs, and that these have a significant inflation driver, a conclusion that is similar to that in . The Gali-Gertler estimation strategy focuses on parameters in the hybrid New Phillips Curve, and finds its estimation results to be robust to wages as a proxy for real marginal costs. As a result, they conclude that from agents’ perspective, inflation can be described as the expected flow of discounted future real marginal costs. This review of econometric specifications shows that the New Keynesian synthesis has satisfied the requirement for the Phillips curve and IS equation to be empirically sound. The next step was to devise a micro-founded general equilibrium model to accommodate these results.

As mentioned before, the way to introduce nominal rigidities in a general equilibrium model is to do away with the assumption that markets operate in a competitive setting. Instead, the model assumes that the economy is made up of a continuum of small, intermediate firms, each with market power over its product. The large number of firms insures imperfect substitution of goods, whereas localised market power allows them to be price-setters. Firms with market power set their prices at a markup, and their aggregate supply is below its competitive, optimal level. argue that real rigidities are not sufficient to generate nominal price stickiness. The literature offers a plethora of explanations in order to account for rigidity in nominal wages and prices. Even as real rigidities are incorporated, without explicit sources of nominal stickiness, prices still adjust instantaneously, in contradiction with the Keynesian hypothesis of fixed, or rigid prices. As a result, nominal rigidities are introduced by means of price adjustment costs à la , or by partial price indexation, per . Ball & Romer argue however that a combination of real and nominal frictions can yield the desired effects from non-neutral money and monetary policy. formulate a baseline framework for monetary policy analysis with a forward-looking IS equation and the New Keynesian Phillips curve, which write respectively:

$$x_t = E_t x_{t+1} - \varphi (i_t - E_t \pi_{t+1}) + g_t$$  \hspace{1cm} (4.1.4)

$$\pi_t = \beta E_t \pi_{t+1} + \lambda x_t + u_t$$  \hspace{1cm} (4.1.5)

Where $g_t$ and $u_t$ are exogenous, stationary shocks. The forward-looking IS equation uses the log-linearised Euler equation yielded from the consumers’ inter-temporal optimisation problem. The New Keynesian Phillips curve (NKPC) is derived from staggered nominal Calvo price-setting, where a fraction of domestic firms update their prices at random.

The New Keynesian model need therefore to be defined beyond its Phillips-IS framework. The Keynesian workhorse is built around the IS-NKPC set of equations, and the New Keynesian synthesis, such as the , deals with monetary policy regimes and their
respective impacts on aggregate welfare. A more comprehensive setting has been offered in Christiano et al. [2005], where nominal rigidities are incorporated in order to replicate observed persistence in inflation and output. The model incorporates Calvo price- and wage-setting, habit-formation, adjustment costs in investment, working capital and capital utilisation. The Christiano et al. [2005] model blends in nominal and real rigidities in order to account for, and estimate fluctuations of macroeconomic variables in the United States. Their results give credence to the Ball-Romer argument, namely that real rigidities alone cannot account for price stickiness, whereas a small measure of nominal price stickiness can generate result such that monetary policy has an impact on real variables. Christiano et al. [2005] also introduce real rigidities because these improve on their model’s ability to replicate stylised facts.

Given that our paper/chapter deals with a small open emerging economy, we also look at New Keynesian literature that deals with nominal rigidities in an open economy environment. Razin and Yuen [2002] extend the standard closed-economy Phillips curve to an open economy with trade and capital mobility. They conclude that opening an economy to trade flattens the Phillips curve, and thus weaken the inflation-output gap tradeoff it describes. Gali and Monacelli [2005] take the New Keynesian workhorse model to a small open economy, and articulate issues. They offer a tractable framework designed to assess the effects of monetary policy on welfare and volatility of exchange rate and terms of trade. Though they conclude that their model is nearly identical to the closed economy standard New Keynesian model, they point out that variable equilibrium conditions are sensitive to the small open economy’s openness to trade, as well as substitutability between domestic and foreign goods. Their results show policymakers in small open economies are faced with a tradeoff between welfare targets and exchange rate stability. For instance, a policy of strict domestic CPI inflation targeting on behalf of monetary authorities yields significant volatility in nominal exchange rate as well as terms of trade. On the other hand, the focus on domestic inflation, rather than a broad-based CPI inflation as defined in a Taylor monetary rule is shown to generates superior welfare benefits.

The framework put forward by Gali and Monacelli [2005] has markedly improved upon the Obstfeld-Rogoff framework in the literature on open economy macroeconomics, but misses out on three aspects. First, their model borrows heavily from the New Keynesian workhorse, where output is entirely consumed, and there are no capital markets. Ireland [2001] argues that the inclusion of physical capital with adjunct costs of adjustment improve on the model’s ability to replicate the behaviour of interest rates. Christiano et al. [2011] discuss the issue where an increase in nominal rates may paradoxically boost inflation if borrowing constraints are included in the model, such as working capital. In that case, intermediate firms face a higher wage bill when interest rates go up, and then pass on the subsequent increase in marginal costs to their prices, thus boosting inflation. Second, it is doubtful labour costs are a pertinent proxy for real marginal costs in emerging economies, where imperfect market structures are prevalent. Woodford [2005] argues that when the New Keynesian model takes into account firm-specific capital, then the predicted slope of the Phillips curve for inflation to the output gap changes dramatically, reflecting the fact that firms engage in strategic interactions within the capita rental market. These changes are echoed in a similar argument made in Christiano et al. [2011]. Third, the Gali-Monacelli model assumes that the domestic bias stems exclusively from household preferences. Rumler [2007] tests the Phillips curve for a set of relatively small open economies in the Euro area. He concludes that open economies tend to adjust their prices more frequently, which is in line with the model’s predictions. A similar exercise is carried out in Mihailov et al. [2011] the parameter that denotes home bias is found not to be statistically significant for many in the country sample, and regardless of the proposed econometric specification. This does not mean that households do not value domestic goods in their consumption index, but may be account for by assuming that they have a considerably low level of elasticity of substitution between imported and domestic consumption goods. This point is vindicated in Watson [2016], where the diversity brought about by openness to trade and imported goods generates ambiguous and
contradictory effects on inflation. On the one hand, increased trade integration raises strategic complementarity between domestic firms, so they are less likely to pass on shocks to their marginal costs, thus raising price stickiness. On the other hand, increased product diversity dilutes their market power, and firms need to adjust their prices more frequently, an assumption backed up by available data. The New Keynesian synthesis in an open economy environment extends the canonical model with a trade component. In doing so, it borrows heavily from another strand of the open macroeconomics literature, one that focuses, among other things, on price distortion and its impact on global trade.

The New Open Economy macroeconomics

Obstfeld and Rogoff [1995] argue that the literature on open macroeconomics suffered hitherto from inherent contradictions: the mainstream models derived from the Mundell-Fleming model (as described and discussed in Mundell 1968, Mundell et al. 2004 and Calvo and Mundell 2001) consisted of an economy system of two markets, one for domestic output, and the other for foreign trade. It sought to describe transmission mechanisms of macroeconomic policies by means of national account identities. Although it was empirically robust and was widely used by policymakers, it did not have a strong theoretical background. Frenkel and Razin [1987] comprehensively enumerate the Mundell-Fleming model limitations. First, its reliance on national accounting means that the model lacked clear micro-foundations, as it did not provide an explicit definition of agents economic behaviour. Second, the lack of inter-temporal resources constraints greatly limits the model’s dynamic scope. Third, the very absence of inter temporal decision-making schedule precludes forward-looking agent decision rules, and limits further the model’s ability to provide predictions in the short and medium run. Fourth, as reported in Obstfeld and Rogoff [1995, 1996] the Mundell-Fleming is mainly demand-driven, and makes no provisions for a supply-side definition of aggregate production, further underlining its lack of micro-foundations.

On the other side of the literature, inter-temporal models have been devised on sound theoretical bases, yet make little room for macroeconomic policy analysis. The standard Walrasian general equilibrium model in an open economy is the International Real Business Cycle (IRBC) model inaugurated in Backus et al. [1992]. Their paper/chapter extends the standard Real Business Cycle (RBC) framework to a multi-country setting. They formulate their model in order to account for co-movements between output and household consumption as observed among OECD economies. Their extended IRBC model is predicated on the assumption that observed fluctuations are the results of agents’ optimal responses to unexpected, exogenous shocks. Their model predicts high correlation between consumption and output among their selected country sample. Backus et al. [1992] conclude to the need for explicit trading fractions in order to improve on the model’s ability to replicate co-movements and global trade. A similar conclusion is shared in Mendoza [1991] whose RBC model is applied to Canada as a proxy for a small open economy. Backus et al. [1992] omit however to discuss issues of macroeconomic policies and their effects on trade flows. While the RBC framework is a state-of-the-art inter-temporal model, one should keep in mind that it is a Walrasian model of general equilibrium. As such, it describes agents’ optimal reaction to exogenous, stochastic shocks. This means that any cycle-smoothing policy is likely to yield low or no welfare gains, whereas macroeconomic variables at Pareto-optimal cannot be improved upon by government policy. As a result, applications of macroeconomic policies are limited. Furthermore, the BRC framework posits that fluctuations are mainly driven by real factors, such as productivity shocks. Coupled with its Walrasian general equilibrium description, it limits greatly its scope and relevance for the study of global trade flows. Finally, the limitations of the IRBC framework are such that the absence of any price-setting mechanism denies the opportunity to predict and test for the dynamics of nominal variables. As a result, these models make no predictions as to inflation, terms of trade or

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exchange rate dynamics, for instance.

Thus the state of inherent contradiction in open economy macroeconomics: on the one hand empirically robust models that lack micro-foundations, and on the other and theoretical models that fail to incorporate macroeconomic policy effects on foreign trade exchange. From this contradiction arises the necessity to conciliate between two requirements: on the one hand, the proposed model has to be consistent and based on sound, micro-founded and theoretical bases. On the other hand, it has to produce relevant economic policy analysis and account for the stylised facts displayed by a comprehensive set of variables.

With Obstfeld and Rogoff [2000] the new mainstream in the literature on open economy macroeconomics is established as a synthesis of the inter-temporal approach and price stickiness. In order to achieve this blend between empirical relevance and theoretical consistency, Lane [2001] points out that imperfect competition is a key component in the New Open Economy macroeconomics literature. Imperfect market structures, such as imperfect competition, bestow some market power on producers, which are thus explicitly defined by their pricing schedule. On the other side, consumers have imperfect elasticity of substitution for available goods. As a result, the combination of monopolistic competition and price sluggishness is achieved within a sound micro-founded framework. Consequently, the new mainstream model is built using monopolistic competition à la Blanchard and Kiyotaki [1987] and make use of the Dixit and Stiglitz [1977] consumption index. There is another purpose to the use of monopolistic competition, one that is more to the point of macroeconomic policy that the New Open Economy macroeconomics literature seeks to describe within a micro-founded setting. When firms are endowed with market power, they set their prices at a markup, above their marginal cost. As a result, supply is below its competitive level, and government intervention becomes desirable, since it can improve on actual level of output, with the proviso that prices do not adjust instantaneously. Furthermore, price sluggishness insures the consumer’s money balance affects their real demand, which opens the way to monetary policy having real and persistent effects on output. In order to achieve price sluggishness, the Obstfeld-Rogoff model further assumes that prices are set in advance. In the face of an unexpected monetary shock, domestic output and consumption increase. The new mainstream allows therefore for macroeconomic policy analysis to be embedded in the inter-temporal framework. Though it has made significant strides in formulating a new open economy macroeconomic framework, the model presented in Obstfeld and Rogoff [1995] does not provide a more exhaustive argument in explaining why domestic firms set their prices in advance. The model also assumes that purchasing power parity always holds, and consumption-based exchange rate is constant. Such assumptions do not hold in an open economy environment. These shortcomings generate two major limitations in the Obstfeld-Rogoff framework: first, one-period advanced price-setting does not compute well with the inter-temporal approach, as agents’ optimisation schedule create expected variable paths. Second, price dynamics need to be defined in a more exhaustive setting, for instance Rotemberg [1982], whose mechanism describes firms facing real costs of price adjustment, or Calvo [1983], where a fraction of intermediate firms update their prices randomly. Végh [2013] argues that households’ consumption path is sensitive, among others, relative consumption goods prices. As a result, constant consumption-based exchange rate is neither a realistic nor consistent assumption. Households adjust their consumption paths on the basis of expected relative prices, which is where comprehensive price adjustment mechanisms are critical to the model’s overall consistency. The focus on path variable with respect to the selected price adjustment mechanism is key to the New Open Economy macroeconomics. Lim and McNelis [2008] argue that a pure forward-looking model within the New Keynesian model can allow for a greater scope in analysis the impact of macroeconomic policy in an open economy environment. Kollmann [1996] develops a model that fits the Obstfeld-Rogoff framework, where prices and wages are staggered and set à la Calvo [1983]. The model predicts a domestic money supply shock would decrease interest rates, generate a depreciation in the exchange rate and increase domestic output.
In addition to monopolistic competition and sluggish price adjustments, the open economy macroeconomics also introduces trade frictions and imperfections to the baseline framework. Obstfeld and Rogoff [2000, 2001] refer to iceberg costs as a fraction of imported goods that melts away due to distance or shipping conditions. The disappearance of a fraction of traded goods is a loss and a cost in itself, but it also distorts significantly relative prices, and thus the mutual benefits from trade. Anderson and van Wincoop [2004] take this argument further, and build a database out of trade indicators in order to formulate estimates of this iceberg costs. Their results suggest that these are substantial, in that trade costs can amount to as much as half the valued added of trade goods. This helps bridge significantly the gap between predictions made by the New Open Economy macroeconomics, and actual trade flows. More recently, a similar exercise is carried out by Irarrazabal et al. [2015], which renew estimates of trade costs. Although their estimates are comparatively lower, they still represent a significant distortion on global trade. They estimate additive barriers at 14% of median prices for traded goods, and find that there are significant welfare losses to the existence of trade costs, due to their distortionary effects on trade. A different avenue is investigated by Ghironi and Melitz [2005]. They incorporate frictions facing domestic firms in order to account for the discrepancies between trade theory and empirical data. They assume that domestic firms face sunk costs and heterogenous productivity shocks, both of which alter substantially the composition of household preferences and their consumption index. The distortion effect arises not from trade costs, but from the inefficiencies and imperfections that face intermediate domestic firms.

To sum up, the Obstfeld-Rogoff framework has defined the New Open Economy macroeconomics paradigm by blending inter-temporal optimisation models with fixed prices. The use of monopolistic competition and price sluggishness blends well with the tenets of the New Keynesian synthesis. Both strands of the literature assume domestic firms become price-setters. In addition, price sluggishness is introduced by assuming randomness (Calvo [1983]) or price adjustment costs (Rotemberg [1982]). As a result, output is set below its competitive level, and the combined effects give room to macroeconomic policy effects. Market imperfection and price sluggishness are two major contributions of the New Keynesian research programme. The New Open Economy macroeconomics extends the neo-Keynesian synthesis to an open economy environment. Further frictions are incorporated, in the form of iceberg costs in Obstfeld and Rogoff [2000] and Anderson and van Wincoop [2004], and inefficiencies and production frictions for intermediate firms, as reported in Ghironi and Melitz [2005].

4.2 The Model

The model we describe in this section borrows mainly from Razin and Yuen [2002] Galí and Monacelli [2005] and Galí [2008]. It represents an open economy where a continuum of firms produce intermediate consumption goods. The representative household in this small open economy values domestic and imported goods. There is a measure of imperfect substitution between the two categories of consumption goods, which makes them strategic substitutes. Furthermore, imported goods face ad valorem iceberg costs, modelled after Obstfeld and Rogoff [2001]. This means that imported intermediate goods are a fraction more expensive at domestic prices. The following subsections describe the optimisation programmes of economic agents in the economy, as well as the optimality conditions we use to build the model as a whole.

The Household

As mentioned above, the household value consumption goods produced domestically and imported from above. We denote $C_t$ the aggregate consumption index, which is defined as a
Constant Elasticity Supply (CES) function:

\[ C_t = \left[ \left( \delta^{1/\eta} C_{h,t} \right)^{\frac{\eta - 1}{\eta}} + \left( (1 - \delta)^{1/\eta} C_{f,t} \right)^{\frac{\eta - 1}{\eta}} \right]^{\frac{1}{\eta - 1}} \]  \hspace{1cm} (4.2.1)

Where \( C_{h,t}, C_{f,t} \) refer respectively to the Dixit-Stiglitz indices of domestic and foreign goods respectively. \( \eta \) refers to the elasticity of substitution between the two categories \( C_{h,t}, C_{f,t} \). Note that the two indices are weighted using \( \delta \in [0, 1] \). [Gali and Monacelli 2005] argue that a certain measure of household-specific domestic bias is needed to compel them to consume domestic goods. Otherwise, the household would prefer to devote all its consumption to imported goods, except for a trivial fraction allocated to domestic consumption goods. Each index is modelled after the [Dixit and Stiglitz 1977] setting. For each category of goods indices \( C_{h,t}, C_{f,t} \), we write:

\[ C_{h,t} = \left[ \int_0^1 C_{h,t}(i)^{\frac{\eta - 1}{\eta}} di \right]^{\frac{\eta}{\eta - 1}} \] \hspace{1cm} (4.2.2)

\[ C_{f,t} = \left[ \int_0^1 C_{f,t}(j)^{\frac{\eta - 1}{\eta}} dj \right]^{\frac{\eta}{\eta - 1}} \] \hspace{1cm} (4.2.3)

Following [Steinsson 2003], we assume that the elasticity of substitution is time-varying. In contrast with [Gali and Monacelli 2005], we assume that the same elasticity applies to all intermediate goods, regardless of their country of origin. This is a realistic assumption as the small open economy does not have an influence on the rest of the world, and as a result its own domestic production of intermediate goods lines up with the rest of the world. We further deviate from the [Gali and Monacelli 2005] setup by assuming the the household does not care about the country-specific origin of its imported consumption. All imported goods are consolidated into \( C_{f,t} \), regardless of the degree of variety coming for each foreign country. We make this assumption in order to focus on the strategic substitution effect between domestic and imported consumption goods. The household does not need to have access to all intermediate goods produced in all other countries. As a result, we argue that it is more realistic to assume that intermediate goods act as strategic complements to each other insofar as there are domestic and imported goods available to consumers. We denote \( P_t, P_{f,t}(i) \) and \( P_{h,t}(j) \) the aggregate index, foreign and domestic prices respectively. The household forms their demand for aggregate domestic and imported goods by taking into account their elasticity of substitution \( \eta \) and their respective price indices. Using equations (4.2.1) through (4.2.3), we write the consumer demand functions for aggregate and intermediate goods as follows:

\[ C_{h,t} = \delta \left( \frac{P_{h,t}}{P_t} \right)^{-\eta} C_t \] \hspace{1cm} (4.2.4)

\[ C_{f,t} = (1 - \delta) \left( \frac{P_{f,t}}{P_t} \right)^{-\eta} C_t \] \hspace{1cm} (4.2.5)

Similar computations can yield demand for intermediate goods, domestic and imported. Intermediate demand functions for domestic and imported goods write as follows:

\[ C_{h,t}(i) = \left( \frac{P_{h,t}(i)}{P_{Ht}} \right)^{-\theta_t} C_{h,t} \] \hspace{1cm} (4.2.6)

\[ C_{f,t}(j) = (1 - \mu(j))^{\theta_t} \left( \frac{P_{f,t}(j)}{P_{f,t}} \right)^{-\theta_t} C_{f,t} \] \hspace{1cm} (4.2.7)

The iceberg cost mentioned in [Obstfeld and Rogoff 2001] shows up in the intermediate demand function for imported goods in equation (4.2.7). Given that a fraction \( \mu(j) \) disappears during the shipping process - imported intermediate goods are not fully available for consumption, and are
therefore pricier, which is reflected in equation (4.2.7). Equations (4.2.4), (4.2.5) are standard expressions for intermediate demand, where consumption is sensitive to price deviation with respect to the benchmark price index. Furthermore, there are two levels of substitution: the direct effect can be observed in the relationship between all intermediate goods, imported and domestic. $\theta_t$ measures the level of elasticity between all goods $C_{h,t}(i), C_{f,t}(j)$. This imperfect elasticity of substitution is a source of real rigidities, since they set output below its competitive level. The expressions for elasticity of substitution in $\theta_t$ and $\eta$ also capture the strategic complementarities between on the one side all intermediate goods, and on the other, domestic and imported consumption goods. As mentioned in Kimball [1995], imperfect competition carries with it apropos features, such as the explicit consumer welfare gains from expanding the continuum of intermediate goods. Intermediate demand increases in the size of the consumption index, which makes intermediate goods strategic complements as well. A second, indirect, effect is reported in equations (4.2.6) and (4.2.7). There is imperfect substitution between imported and domestic goods at their respective aggregate levels. In contrast with Gali and Monacelli [2005], we keep this indirect effect, and show that imperfect substitution between domestic and imported goods contributes greatly to the domestic bias, beyond weightings given by the household to its domestic and imported consumption. Intermediate goods are imperfect substitutes on two fronts: first, all goods are strategic complements to each others, this effect is captured by $\theta$. Second, imported and domestic goods are imperfect substitutes, i.e. $\eta > 1$. In contrast with Gali and Monacelli [2005], we assume that the CES factor in equation (4.2.1) is different from 1, as the special case used in Gali and Monacelli [2005] transforms the aggregate consumption index into a regular Cobb-Douglas specification. This assumes that the proportion of import-to-domestic goods is fixed, whereas the data does not support such an assumption. In addition to these expressions for intermediate demand functions, we also delineate the household through its utility function, which they seek to maximise over an infinite time horizon. The household incorporates aggregate consumption index described above in their utility function, and combine it with labour and a demand shock. The expression writes:

$$U(.) = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[ A_t C_t^{1-\sigma} - \frac{N^{1+\phi}}{1 + \varphi} \right]$$

(4.2.8)

We adopt a more general functional where consumption $C_t$ is fitted into a Constant Relative Risk Aversion (CRRA) specification, with $\sigma$ the elasticity of inter-temporal substitution. Labour $N_t$ generates disutility, and parameter $\phi$ refers to the Frisch Constant Elasticity (CFE). $A_t$ is a demand shock, whose law of motion $\ln A_t = a_t$ is an AR(1) process, with $a_t = \rho a + \varepsilon a_t$. The household seeks to maximise the utility function in equation (4.2.8) subject to resources constraints:

$$P_t C_t + \mathbb{E}_t Q_{t+1} B_{t+1} \leq B_t + W_t N_t$$

(4.2.9)

The household needs to fund its consumption and investment. They use their wages $W_N$ and returns from a given portfolio $B$ with returns $Q$. The optimisation programme allows us to write the following log-linear expression for the Euler equation:

$$c_t = \mathbb{E}_t c_{t+1} - \frac{1}{\sigma} (i_t - \mathbb{E}_t \pi_{t+1} - \ln \beta) + \frac{1 - \rho a}{\sigma} a_t$$

(4.2.10)

The same optimality conditions allow us to equate real wages with the marginal rate of substitution between labour and consumption. The logged expression writes:

$$w_t - p_t = \sigma c_t + \varphi n_t - a_t$$

(4.2.11)

The set of demands expressed by households subject to their utility and resources, as well as the composition of their intermediate demand functions for imported and domestic goods are taken into account by firms, domestic and foreign in their profit-making schedule.
Domestic firms

The domestic economy as well as the rest of the world are populated with a continuum of small intermediate firms over a segment \([0, 1]\). There is a measure of imperfect substitution \(\theta_t\) which gives each firm a limited market power over its own product. A firm indexed \(i\) combines productivity \(Z_t\) and labour in order to produce its own output using a Cobb-Douglas technology. The production function and related marginal cost (denoted \(mc_t(i)\) in log terms) write:

\[
C_{h,t}(i) = Z_t N_t(i)^{1-\alpha}
\]

\[
mc_t(i) = w_t - p_t + \alpha n_t(i) - z_t
\]

Productivity is defined as an exogenous AR(1) process such \(\ln Z_t = z_t \Rightarrow z_t = \rho z_{t-1} + \varepsilon_t\). The marginal cost of each firm is computed as the ratio of real wages relative to the marginal productivity of labour. Given that each intermediate firm possess some market power, domestic and foreign firms alike attach a markup to their marginal costs. As a result, under a regime of flexible prices, the pricing rule would write as follows:

\[
p_{h,t}(i) = \ln \left( \frac{\theta_t}{\theta_t - 1} \right) + mc_t(i)
\]

Nevertheless, nominal rigidities prevent firms from adjusting their prices instantaneously to changes in their marginal cost. We use the definition adopted in Christiano et al. [2005], where firms, where firms face Calvo [1983]-type nominal price indexation contracts. We follow Galí and Monacelli [2005] in adopting the staggered price indexation mechanism put forward in Calvo [1983]. An individual firm faces a probability \((1 - \gamma) \in [0, 1]\) to adjust its price on the next period - a probability, when extended to the whole continuum of intermediate firms, can be transformed into a fraction \(1 - \gamma\) of firms that adjust their prices to their optimal value over time, while the remaining fraction \(\gamma\) do not index their prices. We write the firm-specific inflation rate as follows:

\[
\pi_{h,t}(i) = (1 - \gamma)(\bar{p}_{h,t}(i) - p_{h,t-1}(i))
\]

Where \(\bar{p}_{h,t}(i)\) refers to the price level of a flexible-price regime, i.e. one where the firm can adjust its price instantaneously to changes in their marginal cost. Subsequently, we can write domestic inflation as function of its future, discounted and expected value, and deviations of the marginal cost denoted \(\tilde{mc}_t\). Given the partial indexation at each period, we can write inflation as a function of future expected and discounted changes in the marginal cost, namely:

\[
\pi_{h,t} = \beta E_t \pi_{h,t+1} + \lambda \tilde{mc}_t
\]

Where \(\lambda = (1 - \beta \gamma)(1 - \gamma)\). It can be readily shown that the larger \(\gamma\), the stickier prices are, as they do not follow changes in the average marginal cost. This price stickiness is further compounded in an open economy environment where domestic and imported goods are imperfect substitutes. The reasons behind this are multifarious: there is a strategic substitute element that divorces further changes in the domestic price from the marginal cost, as domestic goods compete with imported ones. In addition, this competition is distorted further due to the existence of iceberg costs which we have introduced in equations \(C_{f,t}\) and \(C_{f,t}(j)\). The trade component of our model allows us to incorporate aggregate inflation \(\pi_t\) as well as the output gap \(\hat{o}_t\) in order to formulate a Phillips equation in an open economy setting.

Trade variables

Before we proceed with formulating an alternative specification for the New Phillips curve in an open economy environment, we need to define trade variables that exert a significant influence on price and output dynamics in the home economy. Galí and Monacelli [2005] and Razín and
Yuen [2002] formulate micro-founded expressions for the exchange rate, nominal and real, as well as the terms of trade, aggregate and bilateral. Recall from equations (4.2.4) through (4.2.7) that the household expresses its demand for intermediate goods as a function of time-varying elasticity of substitution \( \theta_t \) as well as the elasticity of substitution between the aggregate indices of domestic and imported goods. Furthermore, in addition to the exchange rate and terms of trade, we also look at the trade balance of a small open economy. The trade indicators are computed on the basis of the domestic demand described in the previous sub-section. We use the intermediate demand functions for domestic and imported goods in equations (4.2.6) and (4.2.7). We re-write these to show that they are function of openness to trade (domestic bias) and the aggregate price index. In a closed economy setting, relative demand would be solely function of relative prices and elasticity of substitution \( \theta \). In this case however, openness to trade is also taken into account, as it reflects the domestic bias \( \delta \) embedded in household preferences for consumption goods. Similarly, the effective terms of trade \( S_t = \frac{P_{f,t}}{P_{h,t}} \) are also a factor. It is assumed in this model that all intermediate goods are consolidated in CES- and Dixit-Stiglitz indices.

\[
P_{h,t} = \left[ \int_0^1 P_{h,t}(i)^{1-\theta_t} \, di \right]^{\frac{1}{1-\eta}} \tag{4.2.17}
\]

\[
P_{f,t} = \left[ \int_0^1 \left( \frac{P_{h,t}(j)}{1-\mu(j)} \right)^{1-\theta_t} \, dj \right]^{\frac{1}{1-\eta}} \tag{4.2.18}
\]

Note that in our setting, prices for imported goods are skewed upwards due to the existence of iceberg costs. In order to establish a relationship between aggregate and domestic inflation rates, we define the aggregate price index and relative prices as follows:

\[
P_t \left[ (P_{h,t})^{1-\eta} + \left( \frac{P_{f,t}}{1-\mu} \right)^{1-\eta} \right]^{1/(1-\eta)} \tag{4.2.19}
\]

\[
\frac{P_t}{P_{h,t}} = [\delta + (1-\delta)S_t^{1-\eta}]^{1/(1-\eta)} \tag{4.2.20}
\]

Where \( S_t \) refers to the aggregate terms of trade. We write \( \pi_t, \pi_{f,t} \) and \( \pi_{h,t} \) to refer to aggregate inflation, domestic inflation. Using \( s_t \) to denote the logarithmic expression for terms of trade, the expression below establishes the link between aggregate inflation, changes in terms of trade and domestic inflation.

\[
\pi_t = \varphi_s \Delta s_t + \varphi_\pi \pi_{h,t} \tag{4.2.21}
\]

Where \( \varphi_s = \frac{(1-\delta)(\eta-1)(1-\mu) + \eta(1-\delta)}{\eta(1-\mu)} \) and \( \varphi_\pi = \frac{\alpha(1-\mu) + (1-\alpha)}{1-\mu} \).

Equation (4.2.21) differs from that reported in baseline specification in two aspects: first, this paper/chapter posits that \( \eta > 1 \), and therefore assumes that there is a measure of imperfect substitution between aggregate domestic and imported consumption goods. Second, the model incorporates iceberg costs, which have been consolidated into an average value \( \mu \). The expression above collapses into the more standard expression where the difference between total and domestic inflation rates is proportional to changes in the terms of trade when \( \eta = 1 \) and \( \mu = 0 \). In other words, the existence of iceberg costs and strategic complementarity between imported and domestic goods makes the inflation differential more sensitive to changes in terms of trade. Furthermore, irrespective of their values within their respective supports \( \delta, \eta, \mu \), we can show that \( \varphi_s \geq 1-\delta \) and \( \varphi_\pi \geq 1 \). This means that our specification predicts that aggregate inflation is more sensitive to changes in terms of trade, as well as the dynamics of domestic inflation itself. By contrast, when we assume that there are no iceberg costs and no imperfect substitution between imported and domestic goods, the expression we get is \( \pi_t - \pi_{h,t} = (1-\delta)\Delta s_t \) which
is the expression reported in Galí and Monacelli [2005]. We proceed similarly in computing an
expression of the nominal exchange rate, denoted \( E_t \). For a given imported intermediate good
\( j \), we write the following expression:

\[
\frac{P_{f,t}(j)}{1 - \mu(j)} = E_t(j)P^*_f(j)
\]  

(4.2.22)

Where \( P^*_f(j) \) refers to intermediate good \( j \)'s price in foreign currency, and \( E_t(j) \) the bilateral
nominal exchange rate between home and the imported intermediate good’s country of origin.

As we integrate over all imported intermediate goods in equation (4.2.22) and take the expression
in logs, we write:

\[
e_t = s_t - p^*_t + p_{h,t} + \mu
\]  

(4.2.23)

Where \( e_t \) refers to the aggregate exchange rate, \( p^*_t \) the world price index and \( s_t \) aggregate terms
of trade. Again, absent iceberg costs (\( \mu = 0 \)) the expression in equation (4.2.23) collapses
into the standard formulation in the Galí-Monacelli framework. We then proceed with the real
exchange rate, denoted \( Q_t \). By definition, the bilateral real exchange rate writes:

\[
Q_t(j) = \frac{E_t(j)P^*_f(j)}{P_t}
\]  

(4.2.24)

We proceed in a similar fashion in order to formulate an expression for the aggregate real
exchange rate, and write the following expression in logarithmic terms:

\[
q_t = e_t + p^*_t - p_{h,t} + \mu
\]  

(4.2.25)

We plug the expression in equations (4.2.21) and (4.2.23) in order to express aggregate real
exchange rate as a function of terms of trade, and obtain the following expression:

\[
q_t = \varphi_{\mu,s}s_t + \mu
\]  

(4.2.26)

Where \( \varphi_{\mu,s} = 1 + \frac{(1 - \delta)(\eta - 1)}{\eta} - \frac{1 - \delta}{1 - \mu} \). We observe that when \( \mu = 0, \eta = 1 \) the expression
collapses back to the tractable result of \( q_t = \delta s_t \) - where the real exchange rate is commensurate
to the terms of trade. By contrast, our model introduces the distortion effect of iceberg costs
on the real exchange rate, and makes it more sensitive to changes in terms of trade. It can be
readily shown that \( \varphi_{\mu,s} \geq \delta \). In the absence of iceberg costs (\( \mu = 0 \)) and with perfect elasticity of
substitution (\( \eta = 1 \)) the expression in equation (4.2.26) collapses into \( q_t = \delta s_t \) as it is the case in
Galí and Monacelli [2005]. In their setting, the real exchange rate is commensurate to the terms
of trade. In our specification, thanks to iceberg costs and the fact that imported and domestic
goods act as strategic complements, real exchange rate \( q_t \) becomes more sensitive to the terms
of trade \( s_t \). These expressions for the real exchange rate and terms of trade allow us to depict
consumption behaviour in the home economy as a function of the world economy. In particular,
using the Euler equation in (4.2.10), we can write domestic consumption as a function of world
consumption \( C^* \) and the real exchange rate \( Q \).

\[
C_t = C^*_t Q_t^{1/\sigma}
\]  

(4.2.27)

\[
c_t = c^*_t + \frac{q_t}{\sigma}
\]  

(4.2.28)

\[
c_t = c^*_t + \frac{\mu}{\sigma} + \frac{\varphi_{\mu,s}}{\sigma}s_t
\]  

(4.2.29)

We verify that in the absence of iceberg costs and \( \eta \) the expression in equation (4.2.29) changes
into \( c_t = c^*_t + \frac{\delta s_t}{\sigma} \). The expression reverts to the special case mentioned in Galí and Monacelli
[2005] when \( \eta = 1 \) and \( \mu = 0 \). That would mean that domestic consumption exhibits co-
movements with world consumption, and changes with the real exchange rate and terms of

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trade. In our setting, other parameters affect this dynamic. First, the existence of iceberg costs means that there is a fraction $\mu \sigma$ of domestic consumption which is independent of changes in world consumption patterns. This means that the co-movements between domestic and world consumption are commensurate to the terms of trade, and are sensitive to the values assigned to the household domestic bias $\delta$ and CRRA parameter $\sigma$. In the case of our paper/chapter, there are two effects that further exacerbate the co-movements reported in equation (4.2.29). On the one hand, the mere existence of iceberg costs means that a fraction of domestic consumption is divorced from changes in worldwide consumption. This is due to the fact that additional domestic production is needed to make up for the shortfall in imported goods due to the iceberg costs. Furthermore, the imperfect elasticity between domestic and imported goods makes covariances between domestic and world consumption more ambiguous, and depend on the degree of substitution to affect the slope $\varphi_{\mu,s}$. We also define the trade balance-to-output ratio using the difference between output and aggregate consumption. This means that we need to take into account price and exchange rate frictions brought about by the imperfect substitution between domestic and imported goods, as well as the household domestic bias in their preferences for the two categories of consumption goods. We proceed with the following steps: first, we express output as a function of aggregate consumption and the other components that denote the existence of price frictions in the economy. Total output incorporates all production, domestic and imported. It also means that output satisfies all domestic demand, and using equations (4.2.1), (4.2.4) and (4.2.5), we write:

$$Y_t = C_t \left[ \delta \left( \frac{P_{h,t}}{P_t} \right)^{-\eta} + \frac{1 - \delta}{1 - \mu} \left( \frac{P_{f,t}}{P_t} \right)^{-\eta} \right]$$

(4.2.30)

Absent imperfect elasticity of substitution between the two categories of consumption goods, we would have equated output with total consumption. However, because imported and domestic goods are imperfect substitutes and the presence of a domestic bias $\delta$, there are discrepancies between domestic consumption and production, which are accounted for by the elasticity of indices for domestic and foreign goods relative to the aggregate price index. We rearrange the individual components of equation (4.2.30), we write in log terms

$$y_t = c_t + (1 - \delta)\theta_t + \psi_0$$

(4.2.31)

$$y_t = c_t + (1 - \delta)\theta_t + \Psi s t + \psi_0$$

(4.2.32)

Where $\Psi^{s} = \left[ (1 - \delta) + \varphi_{\mu,s} \frac{\delta(\eta \sigma - 1)}{\sigma} \right]$ and $\psi_0 = \frac{\mu \delta(\eta \sigma - 1)}{\sigma}$.

As a result, output increases in the markup shock $\theta_t$ - increasing elasticity of substitution means that all intermediate firms become more competitive and produce more output. Parameter $\Psi^{s}$ is positive for all acceptable value of its individual components $\eta, \delta, \sigma, \mu$. Therefore, output is also increasing in the terms of trade. Note that in the absence of iceberg costs, and when there is perfect substitution between domestic and imported goods $\eta = 1$, as well as a logarithmic utility function $\sigma = 1$, equation (4.2.32) collapses into a more tractable expression

$$y_t = c_t + \frac{(1 - \delta)}{\sigma} s_t.$$ Given that in our model, the real exchange rate is more sensitive to changes in terms of trade in comparison with the [Gali and Monacelli 2005] setup, we can argue that output in our specification is more sensitive to changes in terms of trade than in the benchmark model. As mentioned before, because domestic and imported goods are strategic complements, the friction becomes larger as long as $\eta \neq 1$. This effect is further magnified by the incorporation of iceberg costs, as they distort prices for imported goods. Furthermore, this expression allows us to write domestic output as a function of its worldwide counter part $y^*_{t}$. We use equation (4.2.29) and the assumption that $y^*_{t} = c^*_{t}$ in order to formulate the following expression:

$$y_t = y^*_{t} + \psi^0_{\mu,s} + \Delta(s)s_t + (1 - \delta)\theta_t$$

(4.2.33)
Where \( \psi_{\mu\sigma} = \frac{\mu}{\sigma} + \psi_0 \) and \( \Delta(s) = \frac{\varphi_{\mu,s}}{\sigma} + \Psi_s \).

As it was the case in equation (4.2.29), co-movements between domestic and world output are function of changes in terms of trade, as well as the markup shock. We take advantage of the definitions delineated above in order to formulate net exports as a proxy for the trade balance-to-output ratio. Thanks to the assumption a time-varying elasticity of substitution \( \theta_t \) across all intermediate goods, we can write output as a function of a markup-shock, which has a positive effect. The effects of markup decline when the household weighs more heavily domestic production. Furthermore, the existence of the average iceberg cost \( \mu \) means that output has to be larger in order to compensate for the loss in unsatisfied intermediate demand for imported goods. The real exchange rate plays an ambiguous effect due to the opposite signs of elasticity of substitution \( \eta \) and inter-temporal substitution \( \sigma \). In the special case where \( \eta = \sigma = 1 \) there is no impact of the real exchange rate on output. If not, we can predict that the substitution effect \( \eta \) dominates over the consumption smoothing effect, since \( \eta \geq 1 \) and \( \sigma \geq 1 \). Furthermore, parameter \( \psi_s \) also incorporates the dynamics of the exchange rate and their impact on the synchronisation between domestic and world consumption. Because the household expresses demand for imported goods, we look at net exports as the difference between production and aggregate consumption, as it is the case in the Gali-Monacelli framework. As a result, we denote net exports in logarithmic terms \( nx_t \) and write:

\[
\begin{align*}
nx_t &= y_t - c_t - (1 - \delta)s_t \\
nx_t &= (\Psi_s - (1 - \delta))s_t + (1 - \delta) + \psi_0
\end{align*}
\]

There are contradictory and ambiguous effects between \( \Psi_s \) and \( 1 - \delta \), which measures in effect openness to trade. On the other hand, the trade balance is positively affected by changes in markup - as a more competitive setting means that more domestic goods are produced, and there are fewer consumption goods imported from abroad. Now that these trade variables have been defined, we can formulate open-economy expressions for the twin-components of the canonical New Keynesian model, i.e. the Phillips equation and the forward-looking IS equation.

**Equilibrium: NKPC and Forward-looking IS**

We assume symmetry for all domestic firms, and use the expression for the marginal cost in equation (4.2.13) such that:

\[
mc_t = w_t - p_t + \alpha n_t - z_t - \theta_t \\
mc_t = \sigma c_t + (\phi + \alpha)n_t + \frac{(1 - \delta)(\eta - 1)}{\eta}s_t - a_t - z_t - \theta_t \\
mc_t = \psi_y y_t - \Theta \theta_t + \gamma_s s_t - a_t - \phi z - \sigma \psi_0 \\
mc_t = \psi_y y_t = \psi^*_y y^*_t - \psi \theta t - a_t - \phi z t - \psi_0
\]

Where:

\[
\begin{align*}
\phi_y &= \frac{\sigma - \sigma \alpha + \phi + \alpha}{1 - \alpha} \\
\Theta &= 1 + \sigma - \sigma \delta \\
\gamma_s &= \frac{(1 - \delta)(\eta - 1)}{\eta} - \sigma \Psi_s \\
\phi_z &= \frac{1 + \phi}{1 - \alpha} \psi^*_y = \frac{\gamma_s}{\Delta(s)} \\
\psi_y &= \phi_y + \psi^*_y \\
\psi_\theta &= \Theta + \psi_y^*(1 - \delta) \\
\psi_0 &= \sigma \psi_0 + \psi_{\mu\sigma}
\end{align*}
\]
In the expression of the marginal cost of equation \(4.2.13\), we replace real wages with the marginal rate of substitution between consumption and labour. We also substitute domestic prices with aggregate ones in order to introduce terms of trade in the expression of the marginal cost. As a result, we have established a relationship between the one side, output, the terms of trade and the markup, and the marginal cost on the other side. It can be readily inferred that the markup exercises a negative impact on the marginal cost, and the same goes for productivity. For the terms of trade however, the impact is ambiguous due to the multifarious nature of hyper parameter \(\gamma_s\) which is function of the model’s core structural parameters. This definition of the marginal cost needs to be further described in order to write it as a function of the world output. We formulate a specification of the natural level of output alternative to the one used in Gali and Monacelli [2005]. Instead of assuming the special case where the marginal cost is equal to the markup, we adopt the criterion used by Christiano et al. [2011]. We assume that a social planner seeks to maximise the instantaneous utility function of the household, subject to technology and resources constraints. As a result, the natural level of output \(y^o\) can be written as follows:

\[
y^o_t = \Gamma_0 + \Gamma_a a_t + \Gamma_z z_t
\]  

(4.2.47)

Where \(\Gamma_0 = \frac{(1 - \alpha) \ln(1 - \alpha)}{\sigma(1 - \alpha) + \phi + \alpha}\), \(\Gamma_a = \frac{1 - \alpha}{\sigma(1 - \alpha) + \phi + \alpha}\), and \(\Gamma_z = \frac{1 + \phi}{\sigma(1 - \alpha) + \phi + \alpha}\).

Consequently, when equation (4.2.16) is combined with the output gap \(\tilde{o}_t = y_t - y^o\), we get the following expression for the Phillips equation in an open economy environment:

\[
\pi_{h,t} = \beta \mathbb{E}_t \pi_{h,t+1} + \kappa(\tilde{o}_t - \tilde{o}^*_t)
\]  

(4.2.48)

Where \(\kappa = \psi y \lambda\) and \(\tilde{o}^*_t = \frac{\psi_o}{\psi_y} \theta_t\). Note that trade dynamics feed into the Phillips equation in different ways. The definition of the output gap itself takes into account differences in output between the home economy and the rest of the world. The markup shock, \(\theta_t\) is affected through the collection of parameters \(\psi_o\) and \(\psi_y\). Finally, the Phillips curve slope itself is function of parameters \(\eta, \mu, \delta\), which denote of openness to trade and the frictions attached to it. Thanks to the definition delineated above, we can write an expression for the forward-looking IS equation. We use the log-linear Euler equation (4.2.10), and replace consumption with its expression in equation (4.2.29). We find:

\[
\tilde{o}_t = \mathbb{E}_t \tilde{o}_{t+1} + \left[\frac{\Delta s}{\sigma} - \Psi^s\right] \mathbb{E}_t \Delta s_{t+1} + \frac{1}{\sigma} [i_t - \Delta s \mathbb{E}_t \pi_{h,t+1} - \ln \beta] + \frac{1}{\sigma} \rho_a a_t + \\
(1 - \delta)(1 - \rho a) \theta_t + \mathbb{E}_t y^o_{t+1} - y^o_t
\]  

(4.2.49)

\[
\tilde{o}_t = \mathbb{E}_t \tilde{o}_{t+1} + \Gamma_s \mathbb{E}_t \Delta s_{t+1} - \frac{1}{\sigma} [i_t - r^*_t - \Delta s \mathbb{E}_t \pi_{h,t+1} - \ln \beta] + (1 - \delta)(1 - \rho a) \theta_t
\]

Where:

\[
\Delta s = \frac{(1 - \mu)(1 - \delta)(\eta - 1) + \eta(1 - \delta)}{\eta(1 - \mu)}
\]  

(4.2.50)

\[
\Gamma_s = \frac{\Delta s}{\sigma} - \Psi^s
\]  

(4.2.51)

\[
r^*_t = \sigma ((1 - \rho z) \Gamma_z z_t - (1 - \rho a)(1/\sigma - \Gamma_a)a_t)
\]  

(4.2.52)

Throughout this section, we have used agents’ optimisation programmes to delineate optimality conditions. These have then been fed into national accounting identifies, in order to formulate micro-founded expressions for the Phillips equation, and the forward-looking IS. The model is supplemented with the following set of equations:
The first equation depicts the time-varying markup shock as an AR(1) process. The second equation defines world output as an AR(1) process. The underlying assumption being that for a small open economy, global fluctuations are wholly exogenous, and can therefore be adequately modelled as such. The last equation refers to the Taylor rule, where interest rates are set with respect to aggregate inflation. We have adopted a specification discussed in [Woodford 2001], where the interest rate is smoothed over two periods with its lagged value, and is written as a function of domestic inflation. We have tested for other specifications, listed in [Taylor 2001], and find that our results are robust.

**Calibration**

We use the parameter values computed in the previous chapter for those common parameters, using two databases for our sample set: the World Development Indicators [World Bank] 2018 and the Groningen Growth & Development Center database of [Feenstra et al.] 2015. The following parameters are reprinted: the discount factor $\beta$, labour share of output $1 - \alpha$ and the CRRA parameter $\sigma$. Each one is computed using the standard expressions derived from the canonical Real Business Cycles delineated in the previous chapter. The elasticity of substitution between imported and domestic goods is computed by taking the partial derivative of equation (4.2.1) with respect to imported goods. We replace the partial derivative with the empirical correlation between the two variables, which is combined with their long-run average ratios in order to formulate a calibrated value for parameter $\eta$. Iceberg cost $\mu$ are computed using data from the World Bank and the United Nations COMTRADE database. Numerical values for parameter $\mu$ are computed using the methodology laid out by [Anderson and van Wincoop 2004], there is little consensus as to the size of trade costs, due to their multifarious nature. They incorporate various items, ranging from transport, depreciation as well as tariffs and non-tariffs barriers. [Irarrazabal et al.] 2015 suggest for instance that trade costs account for as much as 14% of the median price, whereas [Ghironi and Melitz 2005] calibrate their model for an average trade cost of 30%. All remaining parameters are estimated using similar specifications. All shock processes are modelled as auto-regressive processes AR(1). We use the time-varying specification of [Steinsson 2003] in order to calibrate values for the elasticity of substitution $\theta_t$. The model explicitly specifies that all intermediate goods are imperfect substitutes to each others, regardless of their country of origin. As a result, the same calibrated values for persistence and standard deviation of this exogenous process will apply to the whole sample. The literature offers a relatively consistent consensus as to the plausible values for which we can calibrate: [Smets and Wouters 2007b] posit a prior persistence of the markup shock at $\rho_\theta = 0.9$, while [Ireland 2004] uses a maximum likelihood estimation of the canonical New Keynesian model to come up a slightly higher value of 0.962, and a standard deviation of 0.0012. Given that our model is an extension of the canonical New Keynesian framework in an open economy environment, we adopt the estimated values in [Ireland 2004] in order to assign numerical values to the markup shock process. For the world output shock, we use the values estimated by [Gali and Monacelli 2005]. They estimate the U.S business cycle using de-trended output data, and assign values $\rho_y = 0.86$ and a standard deviation of 0.0078. In contrast with [Ireland 2004] we adopt a baseline calibration set where the CRRA parameter $\sigma$, is not equal to unity, as is the case for the elasticity of substitution $\eta$. Instead, we calibrate specific values for our sample set. We also calibrate the same standard deviation for productivity shocks for all countries in the sample set.
In order to better appreciate the impact of iceberg trade costs and imperfect substitution between imported and domestic goods, we normalise real shocks to 1%. A similar productivity shock across countries in our sample set allows us to check the level of price stickiness to changes in the marginal cost implied by temporary change in productivity. Differences in impulse response can then be attributed to differences in parameter values, rather than the shock itself. There are additional parameters we have considered for the model. In addition to the Taylor rule as specified in equation (4.2.55), we have incorporated weightings for the output gap, as well as a smoothing component $i_{t-1}$ which is discussed in Ireland [2001].

### Table 4.1: Structural parameters: numerical values

<table>
<thead>
<tr>
<th>Par.</th>
<th>Interpretation</th>
<th>Support</th>
<th>Method</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preferences</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\phi$</td>
<td>Firsch elasticity (CFE)</td>
<td>$] - 1, 1]$</td>
<td>Calibration</td>
<td>$\frac{\partial n^* w}{\partial w n^*} = \frac{1}{1 + \phi}$</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>CRRA parameter</td>
<td>$\geq 1$</td>
<td>Idem.</td>
<td>$M/Y \Delta \bar{v}$</td>
</tr>
<tr>
<td>$\delta$</td>
<td>Domestic bias</td>
<td>$(0; 1)$</td>
<td>Id.</td>
<td>$\ln c_j/c_f$</td>
</tr>
<tr>
<td>$\eta$</td>
<td>Elasticity $C_h, C_f$</td>
<td>$\geq 1$</td>
<td>Id.</td>
<td>$\ln \rho(c_f, c)$</td>
</tr>
<tr>
<td>$\beta$</td>
<td>Discount factor</td>
<td>$&lt; 1$</td>
<td>Id.</td>
<td>$1/(1 + \bar{r})$</td>
</tr>
<tr>
<td><strong>Firms</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\alpha$</td>
<td>Capital share</td>
<td>$(0; 1]$</td>
<td>Id.</td>
<td>$\ln \bar{y} - \ln \bar{n}$</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>Calvo parameter</td>
<td>Id.</td>
<td>Estimation</td>
<td>AR(1)</td>
</tr>
<tr>
<td>$\rho_z$</td>
<td>Persistence - productivity</td>
<td>$] - 1, 1)$</td>
<td>Id.</td>
<td>Id.</td>
</tr>
<tr>
<td>$\sigma_z$</td>
<td>St.dev. productivity</td>
<td>$\geq 0$</td>
<td>Id.</td>
<td>Id.</td>
</tr>
<tr>
<td>$\mu$</td>
<td>Iceberg cost</td>
<td>$(0; 1]$</td>
<td>Data</td>
<td>Tariffs (% Value added)</td>
</tr>
<tr>
<td><strong>Policy &amp; Shocks</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\phi_\pi$</td>
<td>Weighting - inflation</td>
<td>$(0, 1)$</td>
<td>Estimation</td>
<td>GMM</td>
</tr>
<tr>
<td>$\rho_o$</td>
<td>Persistence - demand</td>
<td>$] - 1, 1)$</td>
<td>Id.</td>
<td>Id.</td>
</tr>
<tr>
<td>$\rho_\theta$</td>
<td>Persistence - markup</td>
<td>Id.</td>
<td>Id.</td>
<td>Id.</td>
</tr>
<tr>
<td>$\rho_{y^*}$</td>
<td>Persistence - world output</td>
<td>Id.</td>
<td>Id.</td>
<td>Id.</td>
</tr>
<tr>
<td>$\sigma_a$</td>
<td>St.dev. demand</td>
<td>$\geq 0$</td>
<td>Id.</td>
<td>Id.</td>
</tr>
<tr>
<td>$\sigma_\theta$</td>
<td>St.dev. markup</td>
<td>Id.</td>
<td>Id.</td>
<td>Id.</td>
</tr>
<tr>
<td>$\sigma_r$</td>
<td>St.dev. monetary</td>
<td>Id.</td>
<td>Id.</td>
<td>GMM</td>
</tr>
<tr>
<td>$\sigma_{y^*}$</td>
<td>St.dev. markup</td>
<td>Id.</td>
<td>Id.</td>
<td>Id.</td>
</tr>
</tbody>
</table>

**Note:** Data for all sources spans 1950-2015. We use all available data points for each country in the sample set. Long-run averages of macroeconomic variables are used to approximate the steady-state expressions of model variables. Some parameters are calibrated using steady-state expressions for the Real Business Cycles model, e.g. capital share of output. In the absence of micro-evidence, we derive the expression for the Calvo parameter from an AR(1) specification for inflation. The Taylor rule is computed for nominal interest rates. Estimation is used to extract persistence parameters and standard deviations for exogenous processes. The Taylor rule as specified in Galí and Monacelli [2005] is estimated using GMM. For the sake of robustness, additional parameters have been estimated, mainly for the Taylor rule. The same GMM specification is extended to the additional components. Summary statistics are reported in table 4.2.

We use the stead-state expressions to calibrate values for structural parameters as reported in table 4.1. We report on table 4.2 below the summary statistics of our model parameters:

In our study of the New Phillips equation in an open economy environment, the following parameters are of a particular interest: the Calvo [1983] parameter $\gamma$ denotes of the frequency
Table 4.2: Summary statistics - structural parameters

<table>
<thead>
<tr>
<th>Par.</th>
<th>Interpretation</th>
<th>Mean</th>
<th>Std</th>
<th>Median</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>β</td>
<td>Discount factor</td>
<td>0.932</td>
<td>0.045</td>
<td>0.942</td>
<td>0.701</td>
<td>0.999</td>
</tr>
<tr>
<td>α</td>
<td>Capital share</td>
<td>0.304</td>
<td>0.203</td>
<td>0.269</td>
<td>0.011</td>
<td>0.931</td>
</tr>
<tr>
<td>σ</td>
<td>CRRA</td>
<td>2.636</td>
<td>1.993</td>
<td>1.870</td>
<td>1.021</td>
<td>13.126</td>
</tr>
<tr>
<td>φ</td>
<td>Frisch Elasticity</td>
<td>0.478</td>
<td>0.522</td>
<td>0.380</td>
<td>0.096</td>
<td>4.379</td>
</tr>
<tr>
<td>δ</td>
<td>Domestic bias</td>
<td>0.413</td>
<td>0.213</td>
<td>0.364</td>
<td>0.079</td>
<td>1.624</td>
</tr>
<tr>
<td>η</td>
<td>Elasticity of substitution</td>
<td>5.239</td>
<td>10.482</td>
<td>2.190</td>
<td>1.003</td>
<td>97.074</td>
</tr>
<tr>
<td>γ</td>
<td>Calvo parameter</td>
<td>0.507</td>
<td>0.249</td>
<td>0.531</td>
<td>0.043</td>
<td>0.945</td>
</tr>
<tr>
<td>μ</td>
<td>Iceberg cost</td>
<td>0.141</td>
<td>0.421</td>
<td>0.036</td>
<td>0.001</td>
<td>3.135</td>
</tr>
<tr>
<td>ρz</td>
<td>Persistence - productivity</td>
<td>0.930</td>
<td>0.072</td>
<td>0.949</td>
<td>0.347</td>
<td>0.972</td>
</tr>
<tr>
<td>ρo</td>
<td>Persistence - demand</td>
<td>0.121</td>
<td>0.174</td>
<td>0.106</td>
<td>-0.361</td>
<td>0.487</td>
</tr>
<tr>
<td>ρπ</td>
<td>Weighting - inflation</td>
<td>1.145</td>
<td>0.199</td>
<td>1.091</td>
<td>0.855</td>
<td>2.351</td>
</tr>
<tr>
<td>σr</td>
<td>Std. Monetary</td>
<td>0.066</td>
<td>0.115</td>
<td>0.043</td>
<td>0.010</td>
<td>1.117</td>
</tr>
<tr>
<td>σa</td>
<td>Std. Demand</td>
<td>0.049</td>
<td>0.033</td>
<td>0.041</td>
<td>0.009</td>
<td>0.202</td>
</tr>
</tbody>
</table>

Additional parameters

<table>
<thead>
<tr>
<th>Par.</th>
<th>Interpretation</th>
<th>Mean</th>
<th>Std</th>
<th>Median</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>ρz</td>
<td>Weighting - output gap</td>
<td>0.040</td>
<td>0.371</td>
<td>-0.001</td>
<td>-2.875</td>
<td>1.815</td>
</tr>
<tr>
<td>ρr</td>
<td>Smoothing - policy rate</td>
<td>0.575</td>
<td>0.293</td>
<td>0.653</td>
<td>-0.418</td>
<td>1.038</td>
</tr>
</tbody>
</table>

Note: The baseline dataset covers the period 1950-2015. Calibrated values are computed for available data points within this time period. Unweighted averages and other statistics are reported for all 152 countries in the sample. For additional comments, see table 4.1.

in price changes. Sample-wide average value is 0.507, and should be compared against that calibrated in [Galí and Monacelli 2005] at 0.75 for the United States. Their value assumes that prices change once a year, whereas our sample-wide average implies price changes twice a year on average for a sample of 152 countries. The literature suggests that prices change more frequently in emerging economies. In their literature review, [Klenow and Malin 2010] find that the average mean duration of a price change in developed countries is close to a year, and thus lends credence to the calibration adopted by [Galí and Monacelli 2005]. The same goes for countries in the Eurozone, where mean duration of a price change is 12.3 months. The OECD sample for which [Klenow and Malin 2010] compute the number of price changes exhibits a mean duration of 11.1 months, or an implied average Calvo value of γ = 0.729. By contrast, more emerging economies, such as Mexico and Turkey exhibit more frequent changes in their prices. A mean duration value of 5.7 months is reported for Mexico which implies a Calvo value of 0.473 - which is not far from the value estimated in our model for this country, with γ = 0.402. This result is underlined in [Végh 2013], where it is reported that prices change more frequently in small open economies, and particularly small open emerging ones. We compute an average value for the elasticity between domestic and imported goods following the formulate delineated in table 4.1 at 5.24. In absolute value, it is close to the range of estimates put forward in [Imbs and Méjean 2016] for their sample of 28 developed and emerging countries countries. The large standard deviation of 10.482 suggests that there is a great deal of dispersion around the mean, which is due to the fact that a couple of countries in our sample are significant outliers. The comparatively lower median value of 2.19 for parameter η suggests in fact that our calibrated values using equation (4.2.1) and the correlation between total and imported consumption are much closer to the values estimated and calibrated in [Imbs and Méjean 2016] for trade elasticities. In addition, it vindicates our assumption that the elasticity is different from unity, and that there are substitution effects that should be taken into account in the New Keynesian Phillips curve.

We proceed with group-wise comparisons for predictions generated by our model. We use the World Bank Atlas method to create one baseline category for developed countries, and the remaining categories act as proxies for emerging economies. High-income countries are treated as a proxy group for developed ones. The critical parameters that affect the Phillips curve and
its slope in an open economy environment are reported in figure 4.1 below.

Figure 4.1: Estimated density - structural parameters

Note: See comments on table 4.1. The estimated density is computed using the Normal kernel.

The largest discrepancy in average values between developed and emerging economies can be observed for the Calvo parameter, $\gamma$. The proxy for developed economies, the High income group category, exhibits a bimodal distribution with low and high values for $\gamma$. By contrast, the other countries - emerging economies- appear to cluster more closely around values lower than $\gamma = 0.5$. In other words, High-income countries appear to have either regular price changes, or very seldom, while emerging economies experience on average a price change twice a year. Similarly, we report significant differences in the group-wise average values for parameter $\eta$, the elasticity of substitution between imported and domestic goods. Emerging economies tend to exhibit a higher average value at 6.35, vs. 3.15 for developed countries. It is worth pointing out however that there is a great deal of dispersion around the group mean for non-High income countries. Although the differences are not as large as reported for the two previous parameters, a similar observation can be made as to the calibrated values for the iceberg cost, $\mu$. Reported values for developed economies are very concentrated around the mean value of less than 4%, whereas emerging economies experiences a higher average value of 20%. Recall that the New Phillips equation links inflation with fluctuations in the marginal cost around its average value. We argue in this paper/chapter that openness to trade reduces price stickiness because domestic firms face competition from imported goods. As a result, domestic inflation tracks very closely changes in the domestic marginal cost. By contrast, the incorporation of imported goods in the consumption index raises the substitution effect with respect to domestic goods. Because the two sub-indices act as strategic complements to each other, increased competition can also raise price stickiness, because domestic firms try to adjust their prices with respect to their foreign counterparts more often than to their own marginal costs.

In order to check on the validity of this claim, we compute average values for coefficient $\kappa$ in equation 4.2.48. This parameter determines the Phillips curve slope, and is function of trade indicators, such as the iceberg cost $\mu$, the elasticity of substitution $\eta$ and the domestic bias $\delta$. 
In particular, we write:

\[
\pi_{h,t} = \beta \mathbb{E}_t \pi_{h,t+1} + \kappa (\hat{\theta}_t - \theta_t) \quad (4.2.56)
\]

\[
\pi_{h,t} = \kappa \mathbb{E}_t \sum_{k=0}^{\infty} \beta^{t+k} \left( \hat{\theta}_{t+k} - \rho \hat{\theta}_{t+k} \right) \quad (4.2.57)
\]

As formulated in this model, the Phillips equation in an open economy environment does not differ much from its canonical representation. Inflation can be written as a function of expected deviations of the marginal cost, which is commensurate to the output gap. Our model assumes that the elasticity of substitution between intermediate goods is time-varying, and is an AR(1) exogenous process. As a result, equation (4.2.57) writes inflation as a function of a process \( MA(\infty) \) and future expected values of the output gap. In an open economy environment however, the sensitivity of inflation to changes in the marginal cost become function of trade dynamics. As mentioned before, the existence of imported goods exercise ambiguous and contradictory effects on price stickiness. On the one hand, additional goods raise competitiveness, and thus domestic prices track more closely changes in their own marginal cost. On the other hand, because domestic and imported goods act as strategic substitutes, domestic prices become more sensitive to changes in prices of foreign goods, price stickiness subsequently increases. These effects are captured by the coefficient \( \kappa \) in equation (4.2.48) and we write it follows:

\[
\kappa = \frac{(1 - \beta \gamma)(1 - \gamma)}{\gamma} \left[ \sigma(1 - \alpha) + \phi + \alpha \right] - \frac{(1 - \alpha)(\eta - 1)(1 - \mu)}{(1 - \mu)(1 - \delta)(\eta - 1) + \eta(1 - \delta)}
\]

(4.2.58)

\[
\kappa = \kappa^* - \frac{(1 - \beta \gamma)(1 - \gamma)}{\gamma} \left[ \frac{(1 - \alpha)(\eta - 1)(1 - \mu)}{(1 - \mu)(1 - \delta)(\eta - 1) + \eta(1 - \delta)} \right]
\]

(4.2.59)

Where \( \kappa^* \) is the Phillips slope in a closed economy. Notice that if \( \mu = 1 \) and/or \( \eta = 1 \), then \( \kappa = \kappa^* \). It can be readily shown that \( \kappa \leq \kappa^* \), which means that in an autarkic environment, domestic prices change more frequently, and track more closely changes in the average marginal cost than in an open economy. Regardless, there are two different dynamics incorporated in coefficient \( \kappa \) that need to be disentangled in order to assess domestic price sensitiveness to trade dynamics. To that effect, we compute average values for coefficient \( \kappa \) using the calibrated values of the model’s structural parameters, for each category group in our sample set.

The contour lines reported on figure (4.2) show that high levels of iceberg costs result in a steadily larger value for coefficient \( \kappa \). This can be interpreted as declining domestic price stickiness in trade costs. It also means that high iceberg costs preclude imported goods from acting as strategic complements to domestic ones, thus letting domestic firms adjust their prices primarily with respect to fluctuations of the average marginal cost. Although the respective values for coefficient \( \kappa \) differ across income groups, the dynamics of trade costs and price stickiness are common to all categories. The average coefficient value \( \kappa \) is lowest among developed economies (the High income group) under 0.85, followed by Middle-high income countries at \( \kappa = 1.57 \) and Middle-high income countries at \( \kappa = 3.2 \). Low income countries exhibit the highest average of \( \kappa = 3.72 \). This means that domestic inflation in poorer countries is more sensitive to changes in the marginal cost - or its proxy, the output gap. This is due to the specific values we have calibrated in the previous section, but also due to the fact that emerging economies tend to exhibit higher levels of elasticity of substitution between domestic and foreign goods. This raises the strategic interaction between the two categories, increasing price stickiness as a result.

Figure (4.2) reports the average values for the couple \((\mu, \eta)\) within the contour levels, and compares them against those of the benchmark group of High income countries. As such, it allows us to identify which of the two effects dominates and accounts for price stickiness in an open economy environment. For instance, although low-income economies appear to share a similar low level of trade costs with high-income economies, the average values for \( \kappa \) are wildly different. We ascribe this stark discrepancy to the much higher elasticity of substitution, \( \eta \),
which is close to double-digits for the low-income country group. Although low-income countries experience comparatively lower price stickiness with respect to developed economies, domestic prices in the former would adjust at a rate 7% slower, should they exhibit the same level of elasticity of substitution reported for developed economies. By contrast, Middle-low and High-income country groups share similar levels of elasticity of substitution, but the former exhibit a higher level of trade cost. Should Middle-low income countries converge and reduce their trade costs to the average level observed for developed countries, they would observe an increase in price stickiness, as prices would react 2% more slowly to changes in the average marginal cost.

The contour levels show the contradictory effects of elasticity of substitution $\eta$ and the iceberg cost $\mu$ as reported in as reported in Watson [2016]. Price stickiness increases due to the strategic complementarity between imported and domestic goods, which generates a lower value for $\kappa$. By contrast, higher iceberg costs imply that domestic inflation becomes more sensitive to changes in the marginal cost of domestic firms. This observation makes no prediction as to the level of domestic inflation. Rather, it shows that because domestic firms face less foreign competition, their pricing schedule becomes more sensitive to changes in their marginal costs. With respect to price stickiness in an open economy environment, we extend this analysis further to regional groups, and use the High-income group as a benchmark for comparison.

Regional groups invariably display higher values for parameter $\kappa$, which suggests a lower level of price stickiness in comparison with those values reported for the High income group. The lowest value is reported for Eastern Europe & the Balkans, at an average of $\kappa = 1.15$, and the highest average can be observed in the Middle East & North Africa. We observe similar discrepancies with respect to the level of trade costs and elasticity of substitution between domestic and imported goods. Nevertheless, there are some regional groups that stand out
Figure 4.3: Contour lines - Parameter $\kappa$ with respect to iceberg cost $\mu$ and elasticity $C_f, C_h$ parameter $\eta$. (Regional groups, High income category group as baseline)

**Note:** Contour lines are drawn using group-wise mean values for each income group. The figure reports average values for parameters $\eta$ and $\mu$.

as outliers. For instance, Eastern Europe and the Balkans share similar levels of elasticity of substitution with respect to the High income category group. This may account for the fact that values for coefficient $\kappa$ are the closest the benchmark group. The same can be said as to the differences in $\kappa$ values for Latin America & Caribbean with respect to developed countries. Both regional groups exhibit similar levels of elasticity $\eta$. However, because of the comparatively high level of trade costs $\mu$ in the former, prices are less sticky in this sub-category of emerging economies. In addition, we can also ascribe differences to levels of elasticity $\eta$. That is why domestic prices are less sticky in non-High income countries. Regional groups, such as Sub-Saharan Africa and the Middle-East, exhibit similar levels of trade costs $\mu$, but are significantly more elastic in their domestic and imported consumption. The higher level of elasticity increases competition, which dominates over the strategic complement effect, and thus reduces price stickiness. This explains why $\kappa$ values decline as values for $\eta$ converge to unity, or at least to the average value of High income countries.

In every configuration, the model predicts a small drop in domestic inflation after a positive productivity shock. The real shock affects inflation because it exercises a positive impact on domestic firms’ marginal costs. The whole impact of this positive shock is not entirely absorbed by domestic inflation however. The reasons behind this discrepancy are multifarious. First, the canonical New Keynesian model posits that output is below its competitive level, because firms have a limited monopolistic market power over their intermediate goods. As a result, they do not pass the whole productivity effect onto the consumer - even as the natural level of output increases as well. This explains why the output gap widens - actual and potential levels of output do not real with the same level of magnitude to a positive productivity shock. The natural level of output is not influenced by the market structure of monopolistic competition, whereas actual output takes into account the markup enjoyed by intermediate firms. In addition, because only a fraction of intermediate firms adjust their prices over each period, not all of them will reduce their prices after a productivity shock. As a result, inflation reacts commensurately less to a
real shock than the average marginal cost, or actual output. These frictions are exacerbated in an open economy environment. The canonical open economy setting of the New Keynesian model presented in Razin and Yuen [2002] and Galí and Monacelli [2005] incorporates a sub-category of imported consumption goods. There is a second layer of substitution effect, between intermediate domestic goods on the one side, and between the two indices of domestic and imported goods on the other. Because those two indices act as strategic complements, domestic firms have to take into account the price levels of their imported competitors as well as other intermediate domestic firms. As a result, domestic prices are stickier because they no longer track their marginal costs as closely as they would otherwise. Nevertheless, for a high enough level of substitution effect between domestic and imported goods, the competition effect dominates. Domestic firms need to take into account the disinflationary effect of an expanding continuum of intermediate goods brought about by imported goods. Domestic firms establish a pricing schedule that tracks as closely as possible changes in the marginal cost, in order to face the new competition. The additional feature with which the open economy New Keynesian model has been fitted out accelerates this effect. The model predicted a distortion in relative prices due to the introduction of iceberg costs a la Obstfeld and Rogoff [2000]. This distortion is verifiable in the trade indicators of the canonical model, such as the terms of trade, the real exchange rate and net exports. On the other hand, high trade costs exercise the counter-intuitive effect of reducing price stickiness. This result is counter-intuitive because the distortion introduced by the iceberg cost benefits domestic firms, whose markup increases due to the smaller continuum of intermediate goods available for consumption. Nevertheless, this effect is canceled out because the model is fitted for a small open economy, where domestic intermediate goods face the same elasticity of substitution \( \theta_t \) as their imported competitors. The diversity effect does not come into play. Because there are fewer imported goods on the market, the strategic complement effect cancels out, so domestic firms focus on fluctuations in the average marginal cost. The net result is that high iceberg costs decrease price stickiness because they dominate the opposite effect of the substitution between imported and domestic goods. In addition, the domestic bias in our model is not the sole effect of weighted consumer preferences as reported in equation (4.2.1). The household prefers domestic goods due to the conjugated effects of the iceberg cost and the elasticity of substitution between domestic and imported goods. Finally, differences in price stickiness suggest that they are highest in the category group of developed economies. In other words, price sensitiveness of the Phillips equation to changes in the marginal cost is captured through its slope, coefficient \( \kappa \). Due to the twin combination of small trade costs and low substitution between domestic and imported goods, the average value of \( \kappa \) for developed economies is comparatively low. Other countries, which we consolidate into income and regional groups, exhibit different levels of price stickiness, with higher values for \( \kappa \), and thus a lower level of price stickiness. All category groups of emerging economies exhibit the same dynamics that encompass the contradictory influences of trade cost \( \mu \) and elasticity \( \eta \). High trade costs increase domestic inflation’s responsiveness to fluctuations of the average marginal cost. For the elasticity of substitution, most category groups we have used as proxies for emerging economies exhibit comparatively higher values. As a result, the more elastic the substitution between imported and domestic goods, the lower the value of \( \kappa \), suggesting that the strategic complement effect dominates over all other parameters, thus raising price stickiness.

### 4.3 Conclusions

The implications of the New Keynesian Phillips curve change dramatically when they are transposed to an open economy environment. The closed-economy setting of the canonical New Keynesian synthesis model posits that the Phillips equation slope is a function of price adjustment frequency, which captures the level of price stickiness. Firms adjust their prices according to changes in the average marginal cost, but they also take into account the exogenous random

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process by which prices are adjusted over time. In an open economy environment however, domestic firms need to take into account additional aspects in their price-making schedule. In particular, they have to deal with the dual and contradictory competitive effects of imported goods on their own pricing schedule. This takes the form of increased competition from foreign goods, as well as as rising strategic interactions with the latter, due to the strategic complements element to household demand.

In this paper/chapter, we have extended the New Keynesian model to small open economy. Using the specifications put forward in Razin and Yuen [2002] and Galí and Monacelli [2005], we have formulated a model where the household forms a preference over domestic and foreign goods. Each category was consolidated into a Dixit-Stiglitz sub-index within the aggregate consumption index $C_t$. Given that the model seeks to predict the behaviour of a small open economy, we have assumed that the same elasticity of substitution applies to all intermediate goods, regardless of their country of origin. In addition, we have incorporated trade frictions for foreign goods by introducing iceberg costs, which were defined along the lines of Obstfeld and Rogoff [2000] and Obstfeld and Rogoff [2001]. We have introduced further alterations to the canonical open-economy New Keynesian model by assuming that the elasticity of substitution between domestic and imported goods is larger than unity. This assumption allows us to incorporate explicitly the strategic complements effect between the two categories. These alterations allow us to re-formulate trade variables reported in Galí and Monacelli [2005] with more realistic interactions. For instance, the real exchange rate is no longer commensurate to terms of trade, and instead incorporates trade frictions, such as the iceberg cost, and the domestic bias which we have defined as a weighting for domestic goods in the aggregate consumption index. Similarly, net exports take into account not only the same sources of trade frictions and costs, but also the strategic complements effects between domestic and imported goods discussed earlier. Although the standard specification of the Phillips curve posits that inflation is proportional to fluctuations of the average marginal cost, this prediction is weakened in an open economy environment. The Phillips equation slope becomes a function of trade components, which alters price-setting dynamics in many ways. This model has shown that in addition to the random price adjustment implicit to the Calvo [1983], strategic interactions and trade frictions have ambiguous effects on price stickiness. The first prediction of the Phillips equation in an open economy environment is that prices become stickier, due to the fact that domestic firms no longer adjust their prices following changes in their average marginal cost. Instead, they become more sensitive to changes in prices of imported goods, which are captured by the elasticity of substitution parameter, $\eta$. By contrast, high iceberg costs tend to mitigate this strategic complement effect, and thus reduce the disconnect between the output gap and domestic prices.

We have then put these predictions to the test by using a large sample of countries, developed and emerging. We have identified specific features to developed countries on the one side, and emerging ones on the other. The first observation is that price stickiness is considerably lower in the latter than in the former. The coefficient $\kappa$ in equation (4.2.48) is the Phillips curve slope, and is a function of the two parameters of interest, iceberg cost $\mu$ and elasticity of substitution $\eta$. We have found that almost all emerging economies exhibit a lower level of price stickiness - i.e., a higher value for coefficient $\kappa$ - due to their higher elasticity of substitution parameter, $\eta$. Low income countries for instance exhibited the lowest levels of price stickiness, thanks to their much higher elasticity of substitution. In their case, the strategic complement effect is clearly dominated by the competitive effect, i.e. domestic firms track much closely their marginal costs in their pricing schedule, due to the competition exerted by their foreign competitors. Middle-high income countries on the other hand, tended to exhibit properties similar to those of High income economies, namely a larger price stickiness effect, and a comparable average value for the Phillips curve slope coefficient $\kappa$.

These results can be extended to the capital component in Razin and Yuen [2002]. The
domestic bias that has been described in our model can be applied by the same logic to capital and investment flows to a small open emerging economy. In this case, solvability issues and constraints on the capital account compel domestic firms to use fewer units of capital, and thus rely disproportionately more on domestic capital stock. The common thread is that the domestic bias is not only due to the intrinsic preferences of consumers and/or firms in small open economies, it is also imposed on them by trade and capital flow frictions, as well as the strategic interactions effect implied by the elasticity of substitution between domestic and foreign items.
Bibliography


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Chapter 5

Conclusions and future research projects

– The unlearned start up and take heaven by force,
and we with our learning, and without heart, lo, where we wallow in flesh and blood!

St. Augustine of Hippo - the Confessions.

5.1 Conclusions

In this dissertation, our main contention is that business cycles and macroeconomic fluctuations in emerging economies can be mimicked using general equilibrium models. Despite the well-documented larger magnitude in output and other macroeconomic aggregate fluctuations, the literature has not explored to their full extent the properties of short-run fluctuations in those economies. The reasons have been well documented in Agénor et al. [2000] and ?. This dissertation sought to formulate a general equilibrium model framework with applications to emerging economies. It makes the case for the use of such a theoretical framework through the following steps: first, it catalogues stylised facts observed in emerging economies, in order to characterise their macroeconomic fluctuations as exhaustively as possible. Second, it fits market and institutional imperfections in a rigorous, micro-founded model framework. Third, it argues that these modified general equilibrium models can adequately match and replicate stylised facts collected beforehand. The stated purpose of this dissertation is ultimately to provide policymakers with counterfactual analysis able to quantify welfare gains from cycle-smoothing and stabilisation policies.

In the first chapter, we have found that global factors contribute as much to output volatility in emerging economies as it does in developed ones. The literature states that economic agents in emerging economies stand to gain significantly in terms of permanent consumption per capita thanks to cycle-smoothing policies. Anderson and van Wincoop [2004] show that welfare gains from cycle-smoothing in Latin American economies can increase consumption per capita by 5 to 10%. Reis [2009] applies a similar method to find comparatively smaller, but still large gains for the United States. Nevertheless, since the chapter has shown that external factors account for a sizeable chunk of these fluctuations, there comparatively little room to smooth the cycle further. Emerging countries continue to benefit from reducing the amplitude of the business cycle, but not as much as the more recent literature suggest. Furthermore, ill-designed policies may end up with counter-productive results. ? show that emerging economies experience more downturns due to negative domestic shocks, in the form of self-inflicted policy failures.
The second chapter contributes to the literature on taxation in emerging economies by formulating a Laffer curve atuned to their specificities. The framework put forward by Trabandt and Uhlig [2011, 2012]. We show that the Laffer curve is sensitive to two factors, namely the size of underground economic activities and tax collection costs. The first extension assumed that tax authorities do not have full access to the tax base. The model predicts two contradictory effects: partial access to the tax base means that the tax wedge effect is weaker, which boosts the tax base as a result. Nevertheless, because the government can only extract revenues at a smaller effective tax rate, revenues are low. The second effect clearly dominates, which pushes the Laffer curve downwards and shifts the peak rate to the right. In the second extension, tax authorities face tax collection costs. The government faces costs that arise from inefficiency or difficulties in identifying the tax base. The effective tax rate is higher than expect, and so would the tax wedge effect be on the three tax bases. As a result, the government extracts fewer revenues, and hits a comparatively smaller level of tax peak rate. Consequently, the Laffer curve shifts to the right and becomes steeper beyond its peak. Furthermore, because most countries are below their respective peak rates, tax cuts do not increase revenues, but pay for themselves at higher fractions that usually reported in the literature. For instance, a larger share of declared/taxable economic activities improves tax revenues without distorting significantly the tax base. Similarly, reducing tax cost collection reduces the tax wedge effect, and thus boost the tax base as a result. These policy measures are more linked to the political economy of developing and emerging economies. The integration of undeclared/untaxed economic activities, or the reduction tax collection cost call for changes in institutional arrangements, or cracking down on corruption and inefficiencies to improve tax collection. The distance between steady-state tax rates and their peak values would therefore be function of institutional quality indicators, with the more advanced economies bridging the gap at a faster rate than these with institutions of lesser quality.

In the third chapter, we extend the New Keynesian model to small open economy, using the models of Razin and Yuen [2002] and Galí and Monacelli [2005]. We incorporate trade frictions for foreign goods by introducing iceberg costs, which were defined along the lines of Obstfeld and Rogoff [2000] and Obstfeld and Rogoff [2001]. We also introduce further alterations to the canonical open-economy New Keynesian model by assuming that the elasticity of substitution between domestic and imported goods is larger than unity. Although the standard specification of the Phillips curve posits that inflation is proportional to fluctuations of the average marginal cost, this prediction is weakened in an open economy environment. The Phillips equation slope becomes a function of trade components, which alters price-setting dynamics in many ways. This model shows that in addition to the random price adjustment implicit to the Calvo [1983], strategic interactions and trade frictions have ambiguous effects on price stickiness. The first prediction of the Phillips equation in an open economy environment is that prices become stickier, due to the fact that domestic firms no longer adjust their prices following changes in their average marginal cost. Instead, they become more sensitive to changes in prices of imported goods, which are captured by the elasticity of substitution between domestic and foreign goods. By contrast, high iceberg costs tend to mitigate this strategic complement effect, and thus reduce the disconnect between the output gap and domestic prices. These results can be extended to the capital component in Razin and Yuen [2002]. The domestic bias that is described in our model can be applied by the same logic to capital and investment flows to a small open emerging economy. In this case, solvability issues and constraints on the capital account compel domestic firms to use fewer units of capital, and thus rely disproportionately more on domestic capital stock. The common thread is that the domestic bias is not only due to the intrinsic preferences of consumers and/or firms in small open economies, it is also imposed on them by trade and capital flow frictions, as well as the strategic interactions effect implied by the elasticity of substitution between domestic and foreign items.
These elements contribute to a general improvement of the NKS benchmark. Future research will endeavour to develop applications of nominal and real rigidities in emerging economies. The following topics are of particular interest:

**Further development in the New Keynesian Synthesis framework:** An immediate project I would like to pursue is to further extend the model presented in the third chapter of this manuscript. The model would incorporate similar adjustments of elasticity of substitution to the framework put forward in Razin and Yuen [2002]. The more comprehensive framework would follow in the insights of Christiano et al. [2005] and Christiano et al. [2011], where the focus would be on the dynamics of an open emerging economy. Real frictions and rigidities are generated domestically because of sunk costs and heterogenous productivity levels, as in Ghironi and Melitz [2005]. As the economy would be dependent upon large capital flows due to low investment and/or low capital stock. An interesting research perspective would be to incorporate a public sector with a social planner seeking to improve their country’s competitiveness. Using the Fiscal Devaluation concept of Farhi et al. [2014], where higher consumption rates would provide room for tax cuts in capital and labour.

Joblessness is a particular concern for emerging economies, among others because of their shared demographics (See Veganzones and Pissarides [2006] for countries in the Middle East and North Africa). I am interested in combining three strands of the literature: New Keynesian macroeconomics, labour and development economics. In particular, I would like to extend the framework developed in Blanchard and Galí [2010] and Gali et al. [2011], where the benchmark NKS is supplemented with a matching mechanism on the labour market, the kind developed by Mortensen and Pissarides [1994]. The matching framework models the labour market dynamics in terms of job postings, search cost and matching between unemployed individuals and openings posted by firms. I would like to attach a human capital utilisation component, which I argue captures the persistence of unemployment in many emerging economies. An agent accumulates human capital in order to increase her wage. However, there is capital depreciation when the agent remains unemployed for a period of time. The more time she spends on the labour market looking for a job posting match, the quicker her human capital depreciates, making it harder to fill an opening by the next period. These dynamics are likely to generate not only a high unemployment equilibrium level, but also a persistent unemployment, thus matching a salient stylised fact in emerging economies’ labour markets.

I would also like to explore an intuition I have had recently. There is a growing body of literature on the Monopsony-like nature of the labour market in the United States, and its impact on the wage dynamics (See Ashenfelter et al. [2010], Staiger et al. [2010], Matsudaira [2014], Dube et al. [2018] and Hirsch et al. [2018]). This means the wage dynamics are substantially altered, and many results that are usually derived for the Wage-Phillips equation in the New Keynesian Synthesis are not longer relevant. The monopolistic competition framework allowed workers to exert some markup over their wages, while in a monopsony labour market, wages are stagnant even when the whole economy is at or slightly above its potential output. The paper would renew the erstwhile interest the literature that sought to conciliate this particular market structure with labour. For instance, Phelps [1968] mentions explicitly the case where a dynamic monopsony where the firm wishes to pay workers higher wages than market rates in order to either retain them, or attract outside labour. In my case, the monopsony effect would come into play in the opposite direction, that is, the firm exerts a downward pressure on wages by exercising a firing threat on workers. A similar argument is made by Brinner [1977], where imperfections in the labour market increase the monopsony effect on stagnant wages. A core prediction of this intuition is that, when fitted in the New Keynesian put forward by Blanchard and Gali [2010], the model would predict stagnant wages even as employment increases, and inflation remains low. This is particularly the case in the OECD countries that have picked up growth after recession.
Political economy of high debt in emerging economies: the third chapter of my thesis introduces some degree of political economy in the NKS benchmark model by using strategic interactions between private and public goods, as well as agency interactions in the provision of the latter. I would like to extend this approach to public finances, and to debt dynamics in particular. Starting with the benchmark model in Eaton and Gersovitz [1981] and Eaton and Turnovsky [1983], I am interested in adding two components to its mechanisms of agency theory and political economy. The first assumes that the less effort a government spends in providing the public good, the more expensive it is, and the more reliant the public sector becomes to accumulating debt. The second is an extension of the Aguiar et al. [2009] political economy component of the Eaton-Gersovitz framework. I argue that the agency theory principal described above can be extended to the discount factor used by the government/social planner. The Amador framework posits that the government puts a higher discount rate on future debt repayments, thus increasing its debt issue above its equilibrium level. The same argument can be made over the infinite time horizon using a second social function where the discount factor is conditioned on the level of effort committed to by the government. As a result, emerging economies with imperfect governance would tend to rely on higher levels of debt, and the resulting yield curve would reflect the uncertainty attached to it.
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