Essays on Growth and Environment

Catia Cialani
In loving memory of my father,
because the end of life is not the end of love

To Mrs Milena Parea,
the best teacher I could ever have

This work is also dedicated to all the people
who helped me to find my way and added
a bit of “spice” and a “ray of light” to my life

With all my Heart and with all my Love,

Catia
Abstract

This thesis consists of a summary and four self-contained papers.

Paper [I] Following the 1987 report by The World Commission on Environment and Development, the genuine saving has come to play a key role in the context of sustainable development, and the World Bank regularly publishes numbers for genuine saving on a national basis. However, these numbers are typically calculated as if the tax system is non-distortionary. This paper presents an analogue to genuine saving in a second best economy, where the government raises revenue by means of distortionary taxation. We show how the social cost of public debt, which depends on the marginal excess burden, ought to be reflected in the genuine saving. We also illustrate by presenting calculations for Greece, Japan, Portugal, U.K., U.S. and OECD average, showing that the numbers published by the World Bank are likely to be biased and may even give incorrect information as to whether the economy is locally sustainable.

Paper [II] This paper examines the relationships among per capita CO₂ emissions, per capita GDP and international trade based on panel data spanning the period 1960-2008 for 150 countries. A distinction is also made between OECD and Non-OECD countries to capture the differences of this relationship between developed and developing economies. We apply panel unit root and cointegration tests, and estimate a panel error correction model. The results from the error correction model suggest that there are long-term relationships between the variables for the whole sample and for Non-OECD countries. Finally, Granger causality tests show that there is bi-directional short-term causality between per capita GDP and international trade for the whole sample and between per capita GDP and CO₂ emissions for OECD countries.

Paper [III] Fundamental questions in economics are why some regions are richer than others, why their growth rates differ, whether their growth rates tend to converge, and what key factors contribute to explain economic growth. This paper deals with the average income growth, net migration, and changes in unemployment rates at the municipal level in Sweden. The aim is to explore in depth the effects of possible underlying determinants with a particular focus on local policy variables. The analysis is based on a three-equation model. Our results show, among other things, that increases in the local public expenditure and income taxe rate have negative effects on subsequent income income growth. In addition, the results show conditional convergence, i.e. that the average income among the municipal residents tends to grow more rapidly in relatively poor local jurisdictions than in initially “richer” jurisdictions, conditional on the other explanatory variables.
Paper [IV] This paper explores the relationship between income growth and income inequality using data at the municipal level in Sweden for the period 1992-2007. We estimate a fixed effects panel data growth model, where the within-municipality income inequality is one of the explanatory variables. Different inequality measures (Gini coefficient, top income shares, and measures of inequality in the lower and upper part of the income distribution) are examined. We find a positive and significant relationship between income growth and income inequality measured as the Gini coefficient and top income shares, respectively. In addition, while inequality in the upper part of the income distribution is positively associated with the income growth rate, inequality in the lower part of the income distribution seems to be negatively related to the income growth. Our findings also suggest that increased income inequality enhances growth more in municipalities with a high level of average income than in municipalities with a low level of average income.

Keywords: Genuine saving, welfare change, taxation, per capita GDP, per capita CO$_2$, international trade, net migration, unemployment, growth, inequality.
When I was a child I did not think I would ever go to University, but over the school years, most of my teachers pushed me in that direction. During my education in Italy, I met inspiring teachers, motivating instructors and enthusiastic mentors. Most of them were able to successfully apply to me the Socrates’ maieutic art up until my Laurea at “La Sapienza” in Rome. My “education journey”, after some work experiences, continued abroad; it started some years ago when I moved to Sweden to attend a Master program in Economics. Today, I am even pursuing a Ph.D and I am happy and grateful to many people who helped me to reach this goal.

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1 Happy the one who has been able to know the causes of things/ and trample on all fears and the inexorable fate./ Virgil, “Georgics”, II, 490-493. (Own translation)
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Catia
This thesis consists of a summary and the following four papers:


Paper [I] is reproduced with kind permission from Elsevier Science.
1. Introduction

This thesis consists of four papers. Paper [I] is a theoretical contribution within the area of genuine savings with a focus on a second best economy, where the government raises revenue by means of distortionary taxation. Paper [II] addresses the long-term relationships and short-run causality among per capita GDP, per capita CO$_2$ and a measure of international trade. Papers [III] and [IV] are empirical contributions to the literature on local economic growth. Paper [III] examines the determinants of average income growth, net migration and unemployment rates in the context of a simultaneous equation system, whereas Paper [IV] analyzes the relationship between income growth and income inequality. Both Paper [III] and Paper [IV] are based on data at the municipal level in Sweden.

This introductory chapter is organized as follows. Section 2 presents and summarizes Paper [I], while Section 3 describes Paper [II]. Section 4 presents the background to the second part of the thesis and summarizes Papers [III] and [IV].

2. Measuring genuine saving

The concept of genuine saving (GS) has, in recent years, become widely accepted as a measure for assessing an economy’s local sustainable development. The GS is an indicator of comprehensive net investment i.e., the value of the net investment in all capital stocks of relevance to society. As such, GS does not only reflect the social value of the net investment in physical capital (the measure of the net investment used in conventional national accounting) but also reflects the social value of changes in other capital stocks, such as natural and human capital. An important aspect of GS is that it constitutes an exact measure of welfare change over a short time interval.

A common interpretation is that sustainable development requires welfare to be non-declining over time (Pearce et al., 1989 and Arrow et al., 2003). In economic terms, development is not sustainable if an economy’s total stock of capital is not maintained. Genuine saving is a local indicator of sustainable development, where the emphasis on the word “local” is because we are measuring the welfare change over a short time interval; a non-negative number for genuine saving does not imply that the consumption or utility is sustainable over a longer period.

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1 See e.g. Pearce and Atkinson (1993) and Hamilton (1994, 1996). The GS is also implicit (although not explicitly discussed) in Weitzman’s (1976) welfare measure. See Aronsson and Löfgren (2010) for an introductory text.
2 See Asheim (1994) and Pezzey (1994).
As such, the GS indicator has become an important statistic underlying the environmental policy debate with the World Bank regularly publishing estimates for GS\(^3\) on a national basis for over 150 countries since 1970. The conventional approach to measure GS is to add the value of changes in environmental and/or natural capital stocks to the net investment in physical capital, as well as to add the value of net investment in other capital goods such as human capital.

The GS can be derived from a dynamic optimization model where a planner attempts to maximize the present value of social welfare given a set of constraints. Several researchers have pointed out some conceptual issues for the computation of the GS measure (see e.g. Hamilton and Clemens, 1999; World Bank, 1997, 1999) and a few have criticized the method of calculating the resource depletion rates (see e.g. Neumayer, 2000). Dietz and Neumayer (2004) also argue that the GS is sensitive to the method of calculating rents from resource extraction and claim that the World Bank probably overestimates the unsustainability of certain resource-dependent regions. Also, Pillarisetti (2005) argues that the investment in human capital, measured by education expenses, strongly influences the numerical values of the GS and that policy implications based on this measure can be erroneous. Data limitations are also discussed by the World Bank. Thus, the GS can be a misleading indicator of sustainability and we should, therefore, be cautious in interpreting this welfare indicator.

However, the literature on GS has, so far, neglected the fact that tax revenue is typically collected through distortionary taxes. It is, therefore, important to extend the measurement of GS to a second best economy where policy makers face restrictions preventing them from implementing the first best resource allocation. The primary goal of Paper [I] is to present an analogue to GS in a second best economy based on Chamley's (1985) dynamic model, where the government raises revenues through a distortionary tax.

**Summary of Paper [I]: Genuine saving and the social cost of taxation**

The purpose of this paper is to measure genuine saving when the government raises revenue by means of distortionary taxation. Using a model based on Chamley (1985), we show how the marginal excess burden of taxation contributes to an exact measure of welfare change and, therefore, ought to be reflected in the GS. As such, we modify the conventional measure of GS (calculated as if the tax system is non-distortionary) with an excess of burden that may affect both the sign and magnitude of the welfare change. This means that a second best analogue of the GS may differ in a fundamental way from its first best counterpart.

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\(^3\)The World Bank calculations of GS are now called “adjusted net saving”. 

2
Introduction and Summary

As a supplement to the theoretical model, we illustrate an application by presenting modified GS numbers for Greece, Japan, Portugal, U.K., U.S. and the OECD average. This example is based on the world-bank numbers supplemented by data on budget deficits and estimates of the marginal excess burden in the literature.

3. Pollution, production and international trade

3.1 Long-term and short-term relationships among GDP, CO$_2$ and trade

Is free trade good for the environment? The question of whether international trade hurts the environment or not is of great importance, and much attention has been paid to relationships between carbon dioxide (CO$_2$) emissions, gross domestic product (GDP) and international trade.

Although the long-term relationships and the short-run causality between CO$_2$ emissions, GDP and international trade have been studied over the past two decades, no consensus regarding the so-called CO$_2$ emissions-GDP-international trade nexus has yet been reached. More recent studies have addressed the potential simultaneity of increases in pollution, GDP and international trade rather than assuming (possibly erroneously) that trade and GDP are exogenous determinants of pollution (see, e.g., Anrweiler, Copeland and Taylor, 2001; Frankel and Rose 2005; Managi, 2006, Managi et al., 2009). Frankel and Rose (2005) use an instrumental variables technique to test for a causal relationship between international trade and environmental pollution (sulfur emissions) by analyzing cross-country data for 1990. More specifically, they address the potential endogeneity of international trade and GDP by applying instrumental variables estimation based on a gravity model of bilateral trade and a growth model derived from neoclassical growth theory. The aim of their work is to study the effect of trade on the environmental pollution for a given level of GDP per capita. They set up a three-equation model: one for the GDP, one for environmental pollution (sulfur emissions) and one for trade openness. Their results show that trade reduces the sulfur emissions. Managi et al. (2009) use panel data for sulfur dioxide (SO$_2$), CO$_2$ and biochemical oxygen demand (BOD) emissions for 88 countries during the period 1973 – 2000 and BOD data for 83 countries for the period from 1980 to 2000. Managi et al. treat trade and income as endogenous and find that the qualitative effect of international trade on pollution varies with the type of pollution as well as between countries. Trade is found to benefit the environment in OECD countries. It has detrimental effects, however, on SO$_2$ and CO$_2$ emissions in non-OECD countries, although it contributes to reduce the BOD emissions in these countries.

A recent and emerging line of literature examines the relationship between CO$_2$ emissions and GDP per capita in a cointegration and short-run causal relationship framework. Dinda and Coondoo
(2006) use a cointegration panel data approach to investigate the relationship between income and per capita CO$_2$ emissions in 88 countries from 1960 to 1990. They find evidence for cointegration between these variables for the country groups of Africa, Western Europe, Europe and the World as a whole. They also find a bi-directional causality between GDP and emissions for the country group of Central America, Asia and Africa and for the country groups of Europe. This approach also suggests that there is a distinct difference between the short-term and long-term relationships between CO$_2$ emissions and GDP.

Summary of Paper [II]: CO$_2$ emissions, GDP and trade: a panel cointegration approach

This paper examines the relationship between the gross domestic product (GDP), carbon dioxide (CO$_2$) emissions and international trade. We use a dataset for the period 1960 to 2008, based on 150 countries, which are also divided into two subsamples: OECD and Non-OECD countries. This division allows us to capture differences between developed and developing economies. The paper contributes to the literature in several ways; first, by addressing the endogeneity problem arising from the simultaneous determination of CO$_2$ emissions, GDP and international trade and, second, by using a larger panel dataset in comparison to previous studies (e.g. Dinda and Coondo, 2006; Managi et al., 2009). In addition, the paper addresses panel causality while taking into consideration the heterogeneity in the cross-section units and the non-stationarity of the panel data.

We apply two different classes of cointegration tests: group mean tests and panel tests based on the Error Correction Model (ECM), proposed by Westerlund (2007) and Persyn and Westerlund (2008), to determine the long-run relationship between per capita GDP, per capita CO$_2$ emissions and a measure of international trade. We test whether the null hypothesis of no error correction can be rejected, either for the whole panel or for at least one cross-unit depending on whether a panel or group mean estimation is carried out. Our findings suggest that when we consider robust p-values, provided through bootstrapping, there is a long-run relationship between per capita CO$_2$, per capita GDP and international trade for the whole sample and for Non-OECD countries from the panel tests, while the three variables are cointegrated only for Non-OECD countries from the group mean tests. The short-run causality tests show bi-directional short-term causality between per capita GDP and international trade for the whole sample and between per capita GDP and per capita CO$_2$ emissions for OECD countries. Still, for the OECD sample, our results suggest a causal relationship from per capita GDP and international trade to per capita CO$_2$ emissions, and from per capita CO$_2$ emissions and international trade to per capita GDP. For Non-OECD countries, there are two
unidirectional relationships, from per capita GDP to international trade and from per capita CO\textsubscript{2} emissions and per capita GDP to international trade.

4. Economic growth at local and regional level

4.1 Determinants of economic growth, migration and unemployment

The question of what factors determine income growth has attracted much attention over the last decades. Many studies on regional growth have taken the hypothesis of unconditional and/or conditional\textsuperscript{4} convergence as their point of departure i.e. that poor regions grow faster than rich ones and therefore “catch up” with them. This hypothesis is predicted by neoclassical growth theory as presented by Solow (1956) and Swan (1956). Barro and Sala-i-Martin (1992, 1995) find clear evidence of income convergence between US states, Japanese prefectures and European countries. Using a dataset covering Swedish counties, Persson (1997) finds evidence of unconditional convergence, while Aronsson et al. (2001) and Lundberg (2003) find conditional convergence between Swedish counties and municipalities, respectively. Many studies have focused attention on a broader set of possible determinants of regional growth, such as human capital, labor market characteristics and public policy variables (see e.g., Helms, 1985; Barro, 1991; Galeser et al., 1995; Fagerberg et al., 1997). Another example is Aronsson et al. (2001), who investigate regional income growth and net migration in Sweden, during the period 1970-1995 and include potential determinants such as local human capital, local labor market characteristics, local public expenditure and investment, intergovernmental grants, demographic characteristics and a measure of political stability and leadership.

Analyses of regional income growth are also closely related to population movements and changes in labor supply. The reason is that income growth may be due to changes in labor supply and/or the composition of the labor force, which makes the parameter estimates of empirical growth models difficult to interpret if the effects of population movements are ignored. Therefore, it is also of importance to include population movements in an analysis of regional income growth. Previous studies of migration have found different economic “opportunity” factors such as the expected wage and the probability of receiving that wage (Treyz et al., 1993; Davies et al., 2001) to be important determinants of migration patterns within the USA.

Regional disparities in average incomes, migration and unemployment rates have been on the Swedish political agenda for decades. One important reason is, of course, that Swedish

\textsuperscript{4} Conditional convergence tests focus on the relationship between the income growth rate and the starting position of income, conditional on a set of other explanatory variables.
municipalities are the main providers of welfare services such as child care, primary and secondary education, and care for the elderly, services that are mainly financed by a proportional income tax and through the redistribution system. In particular, the results of Aronsson et al. (2001) suggest that future earning possibilities, expressed in terms of initial average income, attract in-migration. Also, the local human capital endowment (measured by the percentage of the population with a university degree) has a positive effect on the subsequent net migration rate. Lundberg (2003) finds local public expenditure and income tax rates to be important determinants of average income growth and net migration at the municipal level. These results are later confirmed by Lundberg (2006).

Consequently, the ability of local governments to provide these services will depend on the growth of the per capita income, and on whether the municipality and the local private sector are successful in attracting labor (net in-migration) and creating jobs (low unemployment).

4.2 Economic growth and inequality

Following Barro (1991), recent literature has addressed the relationship between growth and inequality by incorporating a measure of income inequality as an additional explanatory variable in growth regression models. Based on this approach, and by focusing on cross-country data, an extensive literature has explored how the distribution of income affects the growth rate of an economy’s GDP. After Simon Kuznets’s (1950) seminal paper in which he argues that there is a trade-off between reducing inequality and increasing economic growth, the mechanisms linking inequality and growth have been extensively addressed in the empirical literature, producing rather conflicting results.

Several studies of the growth-inequality relationship examine a single cross-section of countries and typically find a negative and significant relationship between GDP growth and income inequality (Persson and Tabellini, 1994; Alesina and Perotti, 1996). Other studies, such as Barro (2000) and Forbes (2000), instead report a positive relationship between growth and inequality for relatively rich countries. Similarly, Partridge (1997) finds a positive correlation between GDP growth and the Gini coefficient based on panel data for the US states. Li and Zou (1998) find that the relationship between income inequality and economic growth becomes significantly positive when using panel data (along with appropriate methods for handling such data), while a negative relationship is typically found in single cross-section data. There is also evidence suggesting that the relationship

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5 Kuznets (1955), in his seminal work, suggested the existence of an inverted U-curve between income growth and income inequality known as the Kuznets Curve.
between growth and inequality may vary systematically between countries: Barro (2008) finds that inequality appears to encourage growth in rich countries and slow down growth in poorer countries.

It has been pointed out that, since income statistics may differ significantly between countries due to both the quality and definitions of data, it can be difficult to compare inequality measures between countries (Pardo-Beltrán, 2002). Countries may differ in the “level of democracy, human rights, type of economy, education system etc., which does not make it reasonable to expect that one model holds for all countries” (Nahum, 2005). These issues can be overcome when using data within the same country where many of the institutions are the same.

To our knowledge, there are no previous studies dealing with the relationship between income inequality and growth at the municipal level in Sweden. Previous studies are based on data at the county level (Nahum, 2005) or labor market regions (Rooth and Stenberg, 2012). Nahum (2005) explores the relationship between growth and inequality measured by the Gini coefficient using panel data at the county level from 1960 to 2000. She estimates the effects of inequality measures such as the Gini coefficient, in growth regressions with 1, 3, 5 and 10-year growth periods using fixed effects panel 2SLS estimations and finds a positive effect of inequality on 1 to 5-year economic growth rates (when significant) and no effect on 10-year growth periods. Rooth and Stenberg (2012) analyze the relationship between growth and income inequality based on data for 72 labor market regions in Sweden during the period 1990-2006. The labor market regions were defined using commuting patterns of the labor force provided by Statistics Sweden. Following Voitchovsky (2005), Rooth and Stenberg (2012) investigate whether inequality in different parts of the distribution influences the subsequent economic growth differently. The central hypothesis is that top end inequality encourages growth while bottom end inequality retards growth. Conditional on the Gini coefficient (the measure of overall income inequality), they find a positive relationship between income growth and inequality in the upper part of the income distribution (measured by the ratio between the 90th and 75th income percentiles), while the effect of income inequality in the lower part of the income distribution (measured by the ratio between the 50th and the 10th income percentiles) is insignificant. These results also highlight the potential limitations of studying the impact of inequality on growth based on a single measure of inequality.
Summary of Paper [III]: Growth, migration and unemployment across Swedish municipalities

The purpose of the research described in this paper is to analyze what factors determine the average income growth, migration and unemployment rates at the municipal level in Sweden during the period 1990 – 2007. Although the literature on regional economic growth is quite extensive, this paper contributes to the literature in several ways. In comparison to Fagerberg et al. (1996), who examines the effects of the industrial structure on regional economic growth, this paper focuses on the effects of local policy variables, such as taxes and local public expenditures on regional growth as well as by using a broader set of explanatory variables. Moreover, our data cover a longer period (1992-2007) compared to previous studies based on Swedish municipalities (Lundberg, 2003, 2006; Aronsson et al., 2001; Andersson et al., 2007). The paper also extends previous studies based on Swedish data by taking changes in unemployment into consideration. We estimate a three-equation system for the income growth, net migration rate and unemployment rate using three-stage least squares.

The results provide evidence for conditional convergence, both for municipalities in the major city areas and outside the major city areas. These results are in line with the findings in previous studies based on Swedish data (see above). The initial local public expenditures and local taxes are negatively related to the subsequent local income growth. Moreover, the endowment of human capital, measured as the percentage of the population with at least three years of higher education, is positively related to the subsequent net migration and negatively related to the subsequent changes in the unemployment rates.

Summary of Paper [IV]: Growth and inequality: a study of Swedish municipalities

This paper examines whether income inequality among the municipal residents affects income growth, based on data for 283 Swedish municipalities for the period 1992-2007. We consider different measures of income inequality: the Gini coefficient (as a measure of overall inequality) as well as the income shares of the 25%, 15%, 10%, 5% and 1% top income earners. The ratios between the 90th and 75th income percentile (90/75) and 50th and 10th percentile (50/10) are also included to capture inequality at both ends of the income distribution. We also consider interaction effects between the measures of income inequality and the initial income level. The paper contributes to the literature in several ways. First, as far as we know, there are no studies on this topic at municipal level in Sweden. Second, the paper uses a broad set of inequality measures. The baseline model is based on 5-year growth periods, and we test whether the different inequality
measures, along with other control variables, affect the average income growth at the municipal level.

The results show that an increase in the Gini coefficient (towards more inequality), increases in the different top income shares, and increased inequality in the upper part of the income distribution all contribute to an increase in the subsequent income growth, while inequality at the bottom of the income distribution is negatively related to income growth. In addition, we find a positive interaction effect between inequality and the initial level of average income, suggesting that increased income inequality stimulates income growth more in rich municipalities than in poor municipalities, *ceteris paribus*. 
References


Introduction and Summary


Introduction and Summary


[38] Pezzey, J.C.V., (1994). *The Optimal Sustainable Depletion of non-renewable Resources*, University College London.


