THREE ESSAYS ON ECONOMIC GLOBALIZATION AND REGIONAL INCOME CONVERGENCE

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Abstract

This dissertation consists of three empirical essays, investigating the impact of globalizing flows on the pattern of income convergence at both inter and intra-regional levels. The first essay answers two questions. First, to what extent have peripheral world regions been converging (or diverging) to (or from) the core world region of North America since 1970? And second, what are the effects of globalizing flows on convergence or divergence? Using a panel of ten world regions from 1970 to 2010, our test results indicate that these regions have experienced both convergence and divergence. In terms of the performance of individual peripheral regions relative to the core, there is no evidence that any region has persistently diverged from the core region (in terms of per capita income) since the 1970s. Nor is there any evidence of uninterrupted convergence on the part of any peripheral region. Among globalizing flows, none of them are found to be significantly associated with changes in inter-regional income gaps. Fuel and non-fuel commodity price increases appear to have a stronger deleterious effect on the core region than on peripheral regions, thus providing an impetus for inter-regional convergence.

The second essay seeks to determine the patterns of intra-regional income convergence (or divergence) in Latin America and the Caribbean and assesses the effects of inter- and intra-regional flows on the tendency to converge or diverge. Using time series data for 26 Latin American countries from 1970 to 2010, *log t* convergence tests indicate an overall convergence when per capita income is measured in US dollars and three convergence clubs when per capita income is measured in international dollars. Sigma convergence tests do not show any falling trends in income dispersion for the region and

each of its convergence clubs, regardless of the measurements used for per capita income. Our regression results also suggest that only the flows of inter-regional export and import in high technology products have long-run convergent effects on the pattern of convergence in Latin America and the Caribbean.

The third essay examines the patterns of intra-regional income convergence (or divergence) in East and South-East Asia and investigates the effects of inter- and intra-regional flows on the pattern of intra-regional convergence (or divergence). Using time series data for 17 countries from East and South-East Asia, *log t* convergence tests identify the existence of two convergence clubs for both US and international dollar measurements of per capita income from 1970 to 2010. Although sigma convergence tests do not show any overall convergence trends for the entire period of study, they indicate a persistent decrease in the income dispersion of one club and a relatively stable income distribution in another club over the latest two decades. Our regression results suggest that intra-regional trade, especially intra-regional trade in high-technology goods, has a strong tendency to promote income convergence across countries in East and South-East Asia.

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CHAPTER 1: INTRODUCTION

Since the end of the Bretton Woods system, especially over the last two decades, much has been made of the increasing inter-country flows of goods and services, factors of production and technology that is thought to be a signature of economic globalization. Two major theoretical traditions, neoclassical growth models and structuralist north-south models both suggest that these inter-country flows are likely to generate uneven economic growth between partner countries but predict different outcomes (Lewis 1978, Barro and Sala-i-Martin 1990, Daniel 1991, Singer 1949, Prebisch 1950, Gunnar Myrdal 1957, Wallerstein 1972).[1]

The extensive, and still growing, literature on inter-country convergence typically argues that income convergence (or divergence) is the consequence of uneven economic growth across countries. If we divide the world into several global regions, the uneven economic growth across countries also has implications for inter and intra-regional convergence (or divergence). Therefore, globalizing flows (including both inter- and intra-regional flows) should have inter- and intra-regional convergence (or divergence) implications.

Neoclassical growth models suggest that trade and capital flows will have growth convergent effects (Lewis 1978, Barro and Sala-i-Martin 1990, Daniel 1991). Endogenous growth models suggest cross border flows may cause divergence due to the barrier of

[1] They predict different outcomes because they disagree with whether relatively low income countries grow faster or slower than their high income counterparts.

insufficient capital and knowledge in relatively low income countries (Galbraith *et al* 2006, Datta *et al* 2006, Botta 2009). According to growth pole theory, inter-country flows are likely to cause economic growth around the pole(s). If there is only one pole, the theory implies overall convergence. If there are multiple poles, the theory then predicts club convergence (Perroux, 1956). North-South structuralist models suggest income divergence is likely to be the consequence of the increasing inter-country flows (Gunnar Myrdal 1957, Bornschier 1980, Darity 1990, and Blecker 1996). Therefore, the regional convergence (or divergence) implications derived from these models are far more varied and range from convergence to outright divergence. Given this theoretical ambiguity regarding the likely effect of globalization on inter- and intra-regional income convergence, empirical analyses of actual regional experiences are required to provide some answers.

There have however been no empirical studies on the inter-regional convergence or divergence implications of globalization. Though empirical studies on the pattern of intra-regional convergence have expanded significantly over the last two decades, most of these studies are confined to either the developed regions or some common trade organizations such as the OECD, European Union (EU) North America Free Trade Agreement (NAFTA) and MERCOSUR, a regional trade bloc in South America (Barro 1991, Ben-David 1993, Sanchez-Reaza and Rodriguez-Pose 2002, Madariaga *et al.* 2003, Blyde 2005, Holme 2005, Camarero *et al.* 2002, 2008). Several studies on income distribution in less developed regions focus on the comparison of convergence performance across heterogeneous regions while others focus on the impact of regional trade agreements (Bowman and Felipe

2001, Dobson and Ramlogan 2002, Dobson *et al*. 2003*,[2] Parikh and Shibata 2004*, Galvao and Gomes 2007). In general, there is comparatively little known about the specific effects of globalizing flows on the pattern of intra-regional convergence.

The primary purpose of this dissertation is to go some way toward filling these gaps in the empirical literature. This dissertation consists of three essays investigating the impact of economic globalization on the pattern of income convergence at both inter- and intra-regional levels.

The first essay seeks to expand both the convergence and globalization literature by examining the pattern of inter-regional convergence/divergence among world regions and the role of globalizing flows in that regard. In this essay, first, the world will be divided into ten major regions: Central Asia, East Asia, Eastern Europe, Latin America and the Caribbean, Middle East and North Africa, North America, South Asia, Sub-Saharan Africa, Western Europe and the Pacific Region. Among them, North America is defined as the core region and the remaining regions are designated as peripheral regions. The investigation will be carried in two stages. In the first stage, three tests of convergence (sigma-convergence and pair-wise convergence and lot t convergence tests) will be used to determine whether (and, if so, which) world regions have moved closer together or apart since 1970. In particular, movements relative to the core region of North America will be examined. In the second stage, the relationship of such movements to globalizing flows, together with other variables expected to have effects on convergence, will be investigated using panel data

[2] * studies on the comparison convergence performance across heterogeneous regions

regression analysis. The latter examination will cover only the last two decades since 1990 – a period over which there has been broad consensus about globalization as a generalized phenomenon.

The second and third essays seek to fill the research gap in intra-regional implication of economic globalization. The second essay will begin with the examination of the patterns of income convergence (or divergence) among 26 countries in Latin America and the Caribbean from 1970 to 2010. Specifically, *log t* convergence tests will be used to identify the existence of either overall or club convergence. For comparison, sigma convergence tests will also be used to examine income dispersion among countries within the region and in each of the convergence clubs that may be identified with the *log t* convergence tests. Investigating the specific effects of globalizing flows on the pattern of convergence in Latin America and the Caribbean will be done in the second part of the essay. The relationship between intra-regional income dispersion and inter- and intra-regional flows (together with other variables such as basic determinants of growth and commodity price indices) will be investigated using time series (ARDL) regression analyses.

The third essay will focus on exploring the impact of globalization on the pattern of intra-regional income convergence (or divergence) in East and South-East Asia. Using time series data of 17 East and South-East Asian countries from 1970 to 2010, we will apply the same methodology and technique as that used in the second essay for convergence test and regression analyses. Specifically, *log t* convergence tests will be used to identify the existence of either overall or club convergence. Sigma convergence tests will then be used to examine income dispersion among countries within the region and in each of the

convergence clubs that may be identified with the *log t* convergence tests. In the second part of the essay, the relationship between intra-regional income dispersion and inter- and intra-regional flows (together with other variables such as basic determinants of growth and commodity price indices) will be investigated using ARDL regression models.

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CHAPTER 2: THEORETICAL LITERATURE REVIEW ON THE INCREASED INTEGRATION OF ECONOMIES AND INCOME CONVERGENCE

2.1 INTRODUCTION

Related theories on the increased integration of economies and income convergence have largely been developed with respect to inter-country convergence within a global context. Though few theories specifically address the regional context,[3] the regional implications can often be imputed. If we take a group of regional economies as a sub-set of the global economy, the related inter-country models should apply to intra-regional integration and convergence as well. Moreover, these inter-country models can also be used to analyse the issue related to inter-regional integration and convergence. For example, if convergence exists between every pair of trade partners from two different regions, we would expect there to be a convergence relationship between the two regions as well. Since we are interested in regional income convergence, we start by reviewing inter-country convergence theories and try to impute the implication for regional income convergence (both intra-regional and inter-regional).

The theoretical literature on the increasing integration of economies and inter-country convergence can be divided into two main strands: static theories that focus on the impact of increased integration of economies on relative per capita income levels and dynamic theories that directly address the process of per capita income growth and its

[3] Throughout this text the "region" always refers to world region (a collection of geographically proximal countries) rather than to parts of countries – the more common use of the term.

impact on convergence. Static theories do not define the growth process; however, since they determine how economies relate to each other, they may influence the relative trajectories of growth.

The following section reviews static theories of convergence concerning international trade, capital and labor mobility and technological transfers. In the section following, according to the nature of growth, four categories of dynamic convergence theories are reviewed. The final section briefly summarizes the main approaches for testing evidence of convergences.

2.2 STATIC THEORIES RELATING TO THE INCREASING INTEGRATION OF ECONOMIES AND REGIONAL INCOME CONVERGENCE

Among the static theories relating to increasing levels of transaction across economies and income convergence, one can identify models relating to international flow of goods (and services), capital, and labour. International technology transfers are typically treated as dependent flows that often accompany one of the other three flows, but we will nevertheless review technological transfer theories that drop the assumption of dependency.

2.2.1 International Trade and Regional Income Convergence

Among international trade models, there are two dominant approaches: traditional neoclassical trade models and new trade theory models (NTT). The traditional neoclassical trade models are built on two main assumptions: perfect competitive markets and zero transportation cost. Based on the neoclassical theory of comparative advantage developed by David Ricardo (1817), both partner countries could gain from trade irrespective of

relative income levels. Among these models, the case for international trade lies either in differences in technology or differences in factor endowments and natural resources; either of which will lead to international trade and product price equalization. For example, according to the Heckscher-Ohlin model (Ohlin 1933), trade flows in goods and services reflect differences in factor endowment across nations. Using duality theorems, Dixit and Norman (1980) decomposed goods prices in terms of factor prices (wages, profits, land rents) embedded in unitary costs and showed that the equalization of product prices lead to factor price equalization (the Stolper-Samuelson theorem). By exporting labour-intensive goods, the labour abundant poor nation will make better use of its endowments and raise wages (as trade increases). Capital-intensive exports by the rich nation will lower relative wages. Since wages and per capita income are highly correlated, this will imply a narrowing of the income gap between the poor and rich countries (Easterly, 2004). Interpreted from a regional perspective, inter-regional trade should cause inter-regional convergence[4] and intra-regional trade could have either positive or negative effects on the pattern of inter-regional convergence depending on the nature of the region experiencing intra-regional trade growth.[5] By contrast, intra-regional trade should cause intra-regional convergence and inter-regional trade could have either positive or negative effects on

[4] Inter-regional trade would reduce the differences in factor prices and per capita incomes between two regions.

[5] According to the neoclassical trade theory, every country will benefit from trade; therefore, the relative income of a region is closely related to the quantity of intra-regional trade. When the intra-regional trade of a relatively low income region increases, the income of the region will be increased; hence the income gap between the two regions will be decreased. When the intra-regional trade of a relatively high income region increases, the income gap between the two regions will be increased.

intra-regional convergence depending on which group of countries (rich or poor) are experiencing trade growth.[6]

However, Choi (2007) revisited income convergence, and showed that trade liberalization actually increases the welfare of both countries, but does not necessarily reduce the gap in per capita incomes. According to Choi, although international trade tends to equalize factor prices across countries, the income gap between the two trading countries may still exist due to differences in the capital–labor ratios in the two countries. If increased trade induces less developed countries (LDCs) to accumulate more capital per person, then trade will generate income convergence. If it does not, expanding trade may lead to further income divergence. According to Choi, the implications for both inter and intra-regional income convergences are inconclusive. However, his model does highlight the fact that international trade is not the only factor that affects income convergence. Both capital mobility and labour migration have effects on the capital labour ratio and hence help to determine whether there will be income convergence, divergence or simply persistent income differences.

New trade theory (NTT) is a collection of economic models in international trade that relax the traditional neoclassical trade theory's assumptions. Specifically, one set of NTT models relax the neoclassical assumption of perfect competition and focuses on the role of factors such as economies of scale and network effects and hence imperfect

[6] If the flow of inter-regional trade of a region is mainly from the transactions between relatively low income countries and their external partners, the inter-regional trade flow will help intra-regional convergence. Otherwise it may cause intra-regional divergence.

competition. The focus on imperfect competition suggests new avenues for investigating the relationship between international trade and income convergence. In contrast to the neoclassical trade models, these models show that international trade may increase income gaps across countries. Melitz(2003) argues that when international trade is increasingly liberalized, industries with comparative advantage (greater economies of scale) are expected to expand, while those with comparative disadvantage are expected to shrink, leading to an uneven spatial distribution of the corresponding economic activities. The regional implication of these models suggests that inter-regional trade might lead to inter-regional divergence and intra-regional trade could also cause intra-regional divergence.

Another set of NTT models relax the neoclassical assumption of zero transportation cost. Among them, the geographic trade models relate economic activities to their geographic locations by trying to explain where economic activities are located and why. According to Krugman (1990), as early as 1826, von Thünen already noted that the costs of transporting goods consume some of Ricardo's economic rents. von Thünen also noted that because of transportation costs, rents vary across goods. As well, differences in land intensity per unit of output determine the location of production and distance from the marketplace. The home-market theory is a good example of this class of models. In a paper titled "A Note on Economies of Scale, the Size of the Domestic Market and the Pattern of Trade", Corden (1970) first proposed the concept of home market effects, which was further developed into home market theory by Krugman (1980). The theory states that, if an industry tends to cluster in one location because of returns to scale and if that industry faces high transportation costs, the industry will be located in the country with most of its demand in order to minimize cost. The home market theory implies that intra-regional

trade is more likely to occur than inter-regional trade because of the home market preference.

The gravity models of trade (first used by Tinbergen (1962)) combines economies of scale with transportation cost effect and present a more comprehensive analysis of trading patterns. Specifically, these models mimic the Newtonian law of gravity and predict the pattern of trade based on the distance between countries and the trading countries' economic sizes. The gravity models imply uneven dispersion of international trade flows due to the differences in geographical location and size of economies around the world.

In short, both the geographic trade and gravity models suggest that intra-regional trade should be more common than inter-regional trade. The models also suggest that the growth of intra-regional trade is likely to lead to uneven development concentrated in a few relatively large and advanced economies. Therefore, these models predict divergence at the regional level or the development of convergence clubs (groups of countries converging to similar levels of income). However, given their geographic specificity, no inter-regional implications are obvious from these models.

2.2.2 Capital Mobility and Regional Income Convergence

There exist two theoretical traditions with respect to the effects of capital flows in developing regions. The first tradition is largely based on neoclassical theory, which considers the inflows of foreign capital to be unambiguously beneficial to host countries. This tradition has been regarded as mainstream since it is associated with major international agencies (especially the World Bank). The alternative models, associated with

the structuralist theory, admit to some initial positive impact but argue that net long-run effects are likely to be negative.

The standard neoclassical theory predicts a high marginal product of capital in poorer countries with a low capital-labor ratio. This coupled with limited saving capacity in these countries, should allow for capital to flow from rich to poor countries (Barro, Menkiw and Sali-I-Martin, 1995). Usually, neoclassical models of capital mobility focus on the positive effects of foreign direct investment (FDI) such as productivity enhancement via the transfer of technology and managerial skills, international production networks, and access to external markets (Barro and Sala-i-Martin, 1990). Accordingly, with the diminishing marginal returns assumption of neoclassical theory, we expect inter-regional mobility of capital to reduce differentials in both endowment and marginal product of capital and, in turn, per capita income between partner countries from different regions.[7] This implies that inter-regional capital flows promote inter-regional income convergence. Applying the theory to the intra-regional context, we get a similar implication: that intra-regional capital flows promote intra-regional income convergence.

However, this regional convergence (both inter-regional and intra-regional convergence) implication is based on many restrictive assumptions such as: perfectly competitive capital markets, free capital mobility across borders, clear property rights, complete information, homogenous workers, identical savings preferences, and no asymmetric shocks. Once some of these assumptions are relaxed or other complications are

[7] This process may, however, be slowed and constrained by differential tax rates and limited labor mobility across countries and regions as suggested by Barro, Mankiw & Sala-i-Martin (1995).

considered, capital flows can go in the opposite direction - from developing countries to developed countries (Lucas 1990). Also, the negative effects of FDI may become dominant factors (Hanson, 2001; Lerman, 2002; Dadush and Stancil, 2011), undermining any impetus to regional convergence and possibly leading to either inter or intra-regional income divergence or both.

The structuralist development models, while not necessarily opposing the first tradtion, tend to highlight two adverse effects of FDI (Lo, 2004). The first one is likely to be market disturbance. Usually the carriers of FDI are transnational corporations (TNCs). Having technological and scale advantages over domestic firms, TNCs are likely to extend their monopolistic power into the domestic market of a recipient country. The second one can be inefficient allocation of resource in the forms of excessive duplication of industrial projects, fragmentation of the structures of industries, and obstruction to the development of linked upstream capital-intensive industries. Considering the potential negative effects of FDI, structuralists argue that although recipient countries may benefit from FDI inflows, the returns form FDI are expected to be less stable than those from domestic investment (Firebaugh, 1992, Dixon and Boswell, 1996). Consequently, recipient countries often have to bear the brunt of severe fluctuations in the world economy because any economic benefits they have received is under persistent threat of evaporation. There is no clear convergence implication at either intra or inter-regional level.

2.2.3 Labour Mobility and Regional Income Convergence

Neoclassical inter-country migration theories with underlying assumptions of perfectly competitive markets, unrestricted migration, homogenous labour, perfectly

flexible wages and complete information, posit that labour moves across countries in response to wage differentials. This movement tends to narrow the wage and labour endowment gaps between partner countries (Todaro & Maruszko,1991; Eatwell & Milgate & Newman1987). This will lead, eventually, to convergence in per capita income across countries. As such, this means that inter-regional migration leads to inter-regional income convergence and intra-regional migration leads to intra-regional income convergence. By contrast, other migration models argue that labour is heterogeneous and the effect of labour migration on income convergence actually depends on whether the migrant falls into the category of skilled or unskilled labour. In his dual labour market model, Jennissen (2007) argues that demographic and social changes (i.e. the decline in birth rates and the expansion of education) lead to a relatively small fraction of local workers in developed countries being willing to take jobs at the bottom of the hierarchy. As a result, employers are compelled to recruit unskilled labour from low-income countries, and this leads to a flow of low skilled workers from developing countries to developed countries. The migration flow (dominated by low skilled labour) is likely to reduce the wage gaps across countries. Therefore, the regional implication of the dual labour model would be that inter-regional flows of low skilled labour promote inter-regional convergence. Intra-regional flows will promote intra-regional convergence to the extent that the differential in levels of development across countries in the region induces the type of migration described by this model.

On the other hand, focusing on the effects of high skilled labour migration flows, Gunnar Myrdal (1957) using the concept of cumulative causation argued that developed countries generally attract skilled workers from developing countries, and consequently,

the income gap between developed and developing countries is actually enlarged by this "brain drain". However, Runciman's relative deprivation theory proposes that migration of high skilled emigrants from the developing countries to the developed countries may serve to reduce the income inequality across countries (Runciman, 1966). According to Runciman (1966), high-skilled emigrants are potential (human capital) investors for their home countries. They first equip themselves with advanced technology abroad through learning by doing then capitalize on their skills and contribute to their home countries by providing better schooling for their family members. Moreover, these successful emigrants may then pose as models for their friends and neighbours who aspire to emulate their success. Therefore, whether the migration of high-skilled workers promote (inter and intra-regional) convergence will depend on which of these two effects - human capital drain or human capital investment - is at play.

2.2.4 Technology Transfer and Regional Income Convergence

In reality, the flow of technology is not independent and is usually accompanied by other flows such as trade, capital or migration. Through other inter-country flows, technology transfer may affect income levels of both host and partner countries, and hence regional income distribution. According to Cimoli (1988), technological progress is directly related to either productivity growth, technology evolution or both.

Analyzing the effects of technology transfer, many neoclassical theorists focus on the effects of productivity growth. Under the assumption of perfect competition for both developed and less developed economies, product prices largely depend on market forces. Therefore productivity growth in a country will result in adverse terms of trade if the

growth is concentrated in its export industries and favorable terms of trade if the growth is in its import industries (Hicks 1953 and Johnson 1953, 1954, 1959). Technology transfer is likely to happen through flows of export from developed economies to their less developed partners. As a result, less developed economies will benefit from technology transfer[8]. This implies that technology transfer can reduce the income gap between developed and less developed countries and hence promote income convergence across countries. Applied at a regional level, these neoclassical models would predict positive effects of technology transfer on both intra and inter-regional income convergence.

However, Borenszteina et al (1998) argue that technology spill over will help income convergence only when a sufficient absorptive capability of advanced technology is available in host countries. According to them, in order to obtain a certain level of the absorptive capability, the host countries need to have the minimum threshold stock of human capital. Since relatively poor countries typically have insufficient human capital, they might not be able to benefit from the technology transfer as relatively better off countries can (Acemoglu 2003, Birdsall 2008, Jaumottee et al. 2013). As a result, intra-regional technological spillover might cause intra-regional income divergence, and globally inter-regional technology transfers might have the same effect on inter-regional income distribution as the poorer regions fall further behind.

To analyze the effects of productivity growth, structuralist scholars emphasize the institutional asymmetries between the developed and the less developed economies.

[8] Technology transfer leads to labour productivity growth in import industries of less developed economies, which further turns the terms of trade in their favour.

According to Prebisch (1950) and Singer (1950), labour and output markets in less developed economies are characterized by a high degree of competition while monopolistic corporations and well-organized labour unions are characteristics of output and labour markets in developed economies. Because of the asymmetric structure, neutral productivity growth in developed countries leads to an increase in real wage, favorable (or more favorable) terms of trade, and, consequently, a rise in income while an increase in neutral productivity in developing countries does not change real wages[9] but leads to a decline in the terms of trade[10]. Therefore developing countries cannot gain from productivity growth, instead, they are more likely to lose. From the perspective of productivity growth, international technology transfer will most likely lead to cross country income divergence. Applying this concept to regional income levels, we expect intra and inter-regional flows of technology to have negative effects on intra and inter-regional income convergence.

To investigate the effects of technology evolution, structuralist scholars stress cross country differences in the ability to innovate advanced technology (Posner 196I, Freeman 1963, Hufbauer 1966, and Vernon 1966). According to these structuralists, the evolution of a technology involves three distinct phases. First, new technology starts in advanced economies with sufficient physical and human capital stock. In the second phase the technology evolves into a mature phase, characterized by standardized production. Finally, in the third phase, international competition leads to cost reduction, and as a result the

[9] As result of the unlimited labour supply in less developed countries

[10] Because of the high competition, the prices of products fully depend on supply and demand, the increased supply lowers prices.

technology will be transferred to less developed economies with relatively cheaper labour. According to Cimoli (1998), advanced economies benefit from technology innovation while less developed economies can benefit from technology imitation and diffusion. The technology innovation is expected to induce income divergence while the technology imitation and diffusion is considered as a process of income convergence. This implies international technology spill over will help income convergence across countries. Likewise, technology spill over at the intra-and inter-regional levels will generate income convergence at those levels.

2.3 DYNAMIC THEORIES RELATING TO INCREASED INTEGRATION ACROSS ECONOMIES AND REGIONAL INCOME CONVERGENCE

In this section, a number of dynamic theories relating to increased integration of economies and income convergence are reviewed. In particular, the neoclassical growth models, endogenous growth models, geographical growth models and north-south growth models are reviewed with respect to the integration effects on income growth.

2.3.1 Neoclassical Growth Models

Growth, in neoclassical theory, is generated by increased factors of production or advanced technology. The common presumption for low-income countries is one of abundant labour, but scarce capital and new technology. The shortage of domestic savings is one constraint on domestic capital formation and hence economic growth. The scarcity of advanced technology is another constraint regardless of domestic capital levels. For low income countries, trade and capital flows are supplements for domestic savings and

carriers of technology transfer (Lewis 1978, Daniel 1991). Therefore, these inflows are expected to have growth convergent effects.

The Solow-Swan growth model, a typical neoclassical growth model, predicts dynamic convergence by postulating an inverse relationship between initial income levels and the growth rate of GDP. Therefore, countries that are further away from their steady-state capital labour ratio (and per capita income level) will grow faster than countries closer to their steady-state. Consequently, every country will converge to the same steady state, which is defined as absolute convergence. Some human capital augmented versions of the Solow-Swan model as well as versions that do not assume common saving and population growth rates predict conditional convergence. Specifically that a relatively low income country converges with a relatively high income country if and only if they have similar savings rates (for both physical and human capital). Since considerable financing constraints exist for investment in education, savings rates for human capital vary widely across countries. Therefore, a large amount of countries are unlikely to converge to the same steady state and will instead converge to several different states instead.

In the open-economy versions of these models, the global flows of capital, labour and technology[11] are expected to favour improvement in labour productivity in lower income partner countries, which will further speed up their convergence process (Barro and Sala-i-Martin 1990). Although neoclassical growth models ignore the effects of international trade, such trade is generally expected to enhance the transfer of technology

[11] The Solow-Swan neoclassical growth model takes technology as an exogenous variable and predicts technology transfer will go from advanced economies to less developed economies.

between trade partners. Accordingly, we can expect that international flows of goods and services, capital, labour and technology will favour the growth of the poorer countries. This implies that inter-regional flows might accelerate the inter-regional catching up process (dynamic convergence) while intra-regional flows could help intra-regional convergence and intra-regional club convergence in particular.

2.3.2 Endogenous Growth Models

Endogenous growth models are premised on the understanding that economic growth is driven by endogenous forces instead of exogenous factors. Specifically, investment in factors such as human capital, innovation, knowledge as well as economies of scale and externalities are significant contributors to economic growth. Romer (1986, 1990), Grossman & Helpman (1991) and Aghion & Howitt (1990) incorporate imperfect markets and a research and development (R&D) sector to the growth models. These authors assume that R&D firms are initially able to make monopoly profits by selling ideas to production firms, but with free entry, these profits are dissipated on R&D spending over time. With respect to increased inter-economy flows, these models focus on the positive externalities and spillover effects of technology that will lead to economic growth. One implication of such endogenous growth models is that policies embracing openness and competition will promote growth. Conversely, policies restricting openness and competition by protecting or favouring particular industries or firms are likely to lead to slow growth (Romer, 1986; Lucas, 1988). However, there are many factors that may limit a country's capacity for absorbing new technology. For instance, Klundert and Smulders (1996) argued that the relatively low share in world markets for high-tech products may

discourage low income countries from importing and adopting new techniques. Datta and Mohtadi (2006) cited inadequate human capital as another problem that limits the ability of less developed economies to assimilate knowledge from advanced economies. Galbraith *et al* (2006) stated that insufficient capital could easily trap developing countries in a low-efficiency cycle, because advanced technology could be too expensive to acquire. Botta (2009) argued that good management of the industrialization process should be an unavoidable complementary condition for the success of technology transfer and this requirement may not be easily satisfied in less developed countries.

Other scholars argue that in the context of the global economy, the difference in R & D capacity between the developed and the developing economies is so wide that factor mobility (hence technology spillover) is not a sufficient force for rectification of growth disparities around the world. Benarroch and Gaisford (1997) analyze the dynamics of technological transfers from advanced to less developed economies. According to them, although relatively low income countries gradually gain from the advanced technology through economic interactions, continuing research and innovations in high income countries will keep the technology gap persistent.

Inter-regional differences in R & D capacity need not be the same as global differences (smaller in some cases but possibly larger in others).[12] In that respect, inter-regional trade and factor mobility have no generalized impact on inter-regional convergence. Compared to global difference, intra-regional difference in R & D capacity

[12] For instance, the difference between Latin America and South Asia supposes to be much smaller than the difference between West Europe and West Africa.

should be smaller in most cases. Therefore, intra-regional economic activities may promote intra-regional convergence or generate convergence clubs within a region.[13]

2.3.3 Geographical Growth Models

Agglomeration models are closely associated with economies of scale and network effects. More specifically, production is facilitated where there is a clustering of economic activity and increasing returns to scale. Agglomeration may, however, cause labor shortages and lack of flexibility among firms - as many competitors compete for limited labor and other resources, leading to negative externalities (agglomeration diseconomies). The balance between agglomeration economies and diseconomies determines the growth rate of output in an area. Maintaining stable and high growth through clustering requires that "knowledge spillovers" prevail over the negative externalities (Oflaherty and O'Flaherty, 2009). Martin and Sunley (1998) point out that agglomeration growth models need to be properly "spatialized," not only in the sense of recognizing that the growth mechanisms emphasized by the models operate unevenly across space, but also in the sense of recognizing that those mechanisms are themselves spatially differentiated and in part geographically constituted. Growth poles theory (Perroux, 1956) is an example of combining agglomeration with geographic factors. The core idea is that economic growth is not uniform over an entire region, but instead takes place around a small number of specific poles. Due to economies of scale and agglomeration effects, economies near the growth poles will grow faster than those further away. The closer and more related to the

[13] A small group of countries with similar R & D capacity are more likely to converge to each other by their cross border flows.

poles, the more likely they will replicate the economic performance of the growth pole(s). If we think of regions as consisting of proximal economies relative to the growth pole(s) then this theory suggests that the increased integration of economies within the region will cause the poorer economies of the region to catch up to the core economies (growth poles) of the region. If there is only one pole, the theory implies intra-regional convergence. If there are multiple poles, the theory then predicts club convergence. Because these agglomeration models are related to geographically proximal economies they are not readily applicable to inter-regional economic interaction and thus have limited relevance for inter-regional convergence/divergence.

2.3.4 North-South Growth Models

Structuralist North-South growth model have been used widely to explain the interaction between a less developed "South" or "periphery" economy and a more developed "North" or "core" economy through international flows. The foundation of the model is the identification of an asymmetry between North and South that goes far beyond the neoclassical focus on differences in factor endowments (Gunnar Myrdal 1957). The Northern and Southern economies may differ with regards to both macroeconomic structures and microeconomic characteristics. North and South are specialized in two distinct categories of exports dictated by comparative advantage. Typically, while both countries produce food, which is not traded, North exports manufactured goods, while South exports primary products. North experiences internally generated growth while South's rate of growth depends on the nature of its economic interaction with North.

In Myrdal's (1957) open economy model, a low-per-capita-income (peripheral) economy faced with developmental challenges needs to be understood within the context of its proximity to a high-per- capita -income (core) economy and the related interplay of what he calls "backwash" and "spread" effects. The backwash effects are negative effects on the growth of peripheral economies in the process of increasing economic interrelations with core economies. In particular, the backwash effects occur in the form of the drain of capital and skilled labour and deindustrialization caused by unequal relations. On the other hand, the spread effects mean the spreading of growth benefit (from core economies) to peripheral economies, such as the transfer of new technology. International trade, capital mobility, and labour migration act as carriers of the backwash or spread effects. Most importantly, the balance between backwash and spread effects determines whether there is convergence, club convergence, or divergence. Myrdal (1957) presumed a dominance of backwash effects and, hence, divergence (presumably at both the inter- and intra-regional levels).

The Prebisch-Singer hypothesis derives from such a model. It argues that increased economic interaction between North and South generally results in fast and steady growth in Northern economies at the expense of Southern economies. Developing countries experience declining terms of trade from interactions with the developed countries because of the asymmetric market structure[14] between North and South (Prebisch 1950, Singer 1949). The original explanation put forward for explaining this phenomenon was that North is able to take advantage of productivity growth through increasing wages

[14] Please refer to 2.2.4 Technology transfer and regional income convergence for details.

(resulting in a smaller price effect) while growth in South simply leads to lower prices for South's primary export (and no rise in wages due to weaker bargaining power of periphery workers) that results in a transfer of benefits to North.[15] Therefore, southern countries have to specialise in low technology production in order to exchange (with northern countries) for more expensive high technology products. The result is divergent growth in the long run.

While turning the Marxist notion of class conflict into a question of international conflict, Wallerstein (1972)'s world system theory divides the world into three country groups: core, semi-periphery, and periphery[16]. In the context of a world capitalist system, the core countries primarily own and control the major means of manufacturing in the world and perform the most profitable production activities using their highly skilled labor force and capital-intensive production technologies. The core countries are usually able to purchase raw materials and other goods (such as agriculture products) from non-core countries at low prices, while demanding higher prices for their exports to non-core countries. By contrast, the periphery countries own very little of the world's means of manufacture and they produce certain key primary goods using labour-intensive production processes, with stagnant technology and low-skilled labour. In international economic activities, capital flows from core to semi-periphery and periphery to pursuit cheap labour and raw materials and extend its monopolistic power abroad. As a result, the periphery is exploited by the core and semi-periphery for their cheap labor, raw materials,

[15] Much the same result can be obtained by assuming higher income elasticity for North's manufactured good compared to South's primary product.
[16] The division of labour in Wallerstain's world system is based on the differences in technology

and agricultural production. The semi-peripheral countries, which include declining core countries and economically advancing periphery countries, are somewhat intermediate. They are exploited by the core nations but they in turn take advantage of the peripheral nations. International trade and capital flows associated with economic interdependence accelerate the implementation of the division of labour, which in turn reinforces the dominance of the core. In general, core countries and some semi-periphery countries grow at the cost of periphery countries. Wallestein's world systems theory predicts that inter-regional flows of trade and capital will cause growth divergence (between developed and developing regions). Within regions, movements of trade and capital can cause convergence, divergence or balanced growth (little change in the cross-country distribution of incomes) depending on the degree of differentiation in technology across the region. Presumably, relatively homogenous regions (containing mostly one type of economy) will either experience little change in the distribution of incomes or convergence, while heterogeneous regions (containing core, semi-periphery and periphery economies) are likely to experience divergence.

Meanwhile, other political economy theories are based on the idea of the internationalization of capital. In particular, they posited that capital export from advanced countries is typically motivated by demand deficiency in the home market. By directly investing in less developed countries, multi-national companies (MNCs) extend their monopolistic power to foreign markets (Daniel 1991). However, for less developed countries, local producers are crowed out and local industries are largely controlled by MNCs. Consequently, less developed countries have to suffer domestic deindustrialization and various fluctuations in the world economy, which in turn affects potential growth

adversely. This expected result is in line with the prediction of Wallestein's world system theory, therefore, theories related to internationalization of capital are likely to have the same regional convergence implications as those of Wallestein's world system theory.

2.3.5 Modern North-South Models

Modern North-South theories, while retaining most of the assumptions of earlier structuralist theories, employ more mathematically formalized models. These models maintain the twin assumptions of asymmetric economic structures (between hypothetical North and South economies) and asymmetric patterns of specialization in production (Darity and Davis, 2005). These models also typically retain the assumption that growth in North is internally determined while growth in South is externally generated (dependent on Northern growth). Some of these models have been concerned with the long-term effect of trade between North and South while others have investigated the long run impact of capital flows[17]. The specific implication of technology flows have generally not been a central concern of these models.[18] However, the effects of productivity growth and technology evolution (discussed in 2.2.4) could be also applied to the case of growth convergence.

One group of the modern North-South models primarily focuses on the long term effect of North-South Trade. For example, Findlay (1980) concluded that trade would result in convergence in growth although the income gap between North and South would

[17] Scholars appear to be more concerned with FDI than portfolio flows.
[18] The effect of technological progress and/or technology flows have been much more a concern of North-South endogenous growth models – which, though they share some commonalities, do not include the fundamental structural asymmetries that structuralist models insist upon.

be sustained. As well, Botta (2009) concluded that income level convergence, growth convergence (without income level convergence) or income divergence were all possible long term outcomes from North-South trade, depending on the level of industrialization achieved by South and the institutional and policy environment accompanying that industrialization.

Another group of modern North-South models investigates the long run effect of capital flows between the North and South and cannot reach unanimous conclusion. Traditional economic models have regarded the inflows of foreign investment to create export and import-substitution industries as unambiguously beneficial to the host country (Daniel 1991). Some modern North-South models focus on the contagion effects of advanced technology and management practices by MNCs and postulate that FDI contributes more to economic growth (in host countries) than domestic investment (Findlay 1978, Wang 1990). Therefore, the impact of FDI on intra-regional convergence is likely to be positive, which is in line with the prediction of neoclassical growth models. Considering the limitation of absorptive capability of recipient countries, Borensztein (1998) argues that FDI generates economic growth only when host countries have a minimum threshold stock of human capital. Burgstaller and Saavedra-Rivano 1984 conclude that a balance growth path (growth convergence without income convergence) is the likely outcome of cross border capital mobility.

Based on adverse effects of FDI[19], other modern North-South models suggest that foreign investment is not as "good" as domestic investment in generating economic growth (Firebaugh 1992, Dixon and Boswell 1996). For them, due to the differential productivity, which is the expected outcome of the FDI disturbances, the convergent effects of FDI are supposed to be weak. Bornschier (1980), Darity (1990), and Blecker (1996) conclude that divergence is the likely outcome in long run.

Structuralist models of dependence suggest that capital flows carried by multinational corporations (MNCs) have two different effects: MNC penetration and MNC investment (Bornschier 1980). MNC investment refers to the capital inflows (brought by MNCs) from core to peripheral economies in the form of new investment. MNC penetration refers to the capital outflows from peripheral economies back to core in the forms of transferred profits, interests on loans, royalties, licenses and management fees. For host economies, MNC investment is likely to increase economic growth in the same period whereas MNC penetration probably lowers the subsequent growth rate due to the effect of decapitalization (Bornschier 1980).

Some dependency theorists have postulated the concept of dependence based on MNC investment. For them, the growth in the periphery is subjected to the capital inflows from the core (Ghosh 2003, 2001, Crane and Amawi, 1997). Since MNC investment is not based on host counties' macroeconomic performance, beside temporary economic growth, it may also generate substantial problems such as macroeconomic vulnerability,

[19] According to the authors, the adverse effects of FDI are usually in the forms of less linkage to domestic economy, inappropriate technology, less profit reinvestment, less development of local business.

unsustainability, deindustrialization and even financial crisis (Ghosh 2003, 2001, Crane and Amawi, 1997). Other dependency theorists such as Dixon and Boswell (1996) have related the concept of dependence to MNC penetration. MNC penetration is negatively related to growth rates in the long run. In short, for low income countries, capital outflows are likely to have regional divergence effects while the impacts of capital inflows are not conclusive.

2.4 RELEVANT MEASURES OF DIFFERENT CONCEPTS OF CONVERGENCE

2.4.1 Sigma Convergence Test for Income Level Convergence

The theoretical interest in convergence/divergence across economies has been supported with attempts to search for direct empirical evidence of convergence or divergence. The earliest formal attempts at a numerically succinct measure of convergence utilized a direct measure of dispersion, the standard deviation, to uncover the degree of contraction or expansion of the distribution of incomes across economies (Easterlin, 1960; Borts and Stein, 1964). A finding of declining standard deviation of (the log of) incomes across economies is referred to as σ-convergence. This measure is part of a class of measures, referred to as the distribution approach that utilizes information about the distribution of incomes in searching for evidence of convergence (or divergence). As a general measure that provides information only about the nature of the distribution, σ-convergence provides little information on the precise nature of convergence and is thus difficult to attach to a specific theory. However, it offers a direct estimate of what is the

generally accepted indicator of convergence (divergence) - the tendency of per capita output differences among countries or regions to decrease (increase) over time.[20]

2.4.2 Beta Convergence Test for Growth Convergence

Another similarly succinct measure of convergence is based on the assumption that if economies are converging, the rate of growth of individual economies will be inversely related to their starting position in the hierarchy. Therefore, the finding of a negative coefficient on initial country incomes in a growth regression is interpreted as evidence of β-convergence. In its first use by Baumol (1986) the coefficient was used simply to confirm a statistical regularity. However, later contributions by Barro and Sala-i-Martin (1992) and Mankiw, Romer, and Weil (1992) formally derived the beta coefficient from the parameters of a neoclassical growth model. Since then, a finding of β-convergence has largely been interpreted as confirmation of the predictions of the neoclassical growth model either in the sense of convergence to a single, equilibrium, level of income (absolute convergence) or to various stable equilibria dictated by structural parameters (conditional convergence). This measure has largely been applied to cross-section and panel data. However, its broad interpretation as a measure of convergence has been challenged by several researchers, including Quah (1993) and Friedman (1992), who argued that the finding of a negative coefficient on initial income can occur even if static convergence, the reduced dispersion in incomes, is not occurring. In short, β-convergence is a necessary but not sufficient condition for σ-convergence (Islam, 2003).

[20] However, this measure cannot distinguish between transitional dynamics and long-term movements.

2.4.3 Time Series Measures of both Level and Growth Convergence

With access to long time series on country incomes, researchers have been able to develop measures of convergence that take advantage of the information provided by time series data. In that regard, Bernard and Durlauf (1995) developed the concepts of *convergence in output* and *common trends in output*. Convergence in output (across several countries) is said to occur when the long term forecast of output for a group of economies is equal at a fixed point in time. Thus, where *y* is the log of per capita output:

$$\lim_{k\to\infty} E\left(y_{1,t+k} - y_{p,t+k}\middle|I_t\right) = 0 \qquad \forall p \neq 1$$

A common trend in output is said to occur when the long term forecast of output for a group of economies can be reduced to fixed proportions at a specific point in time.

$$\lim_{k\to\infty} E\left(y_{1,t+k} - \alpha_p' y_{p,t+k}\middle|I_t\right) = 0 \quad \forall p \neq 1$$

In effect, convergence in output describes static convergence or level-convergence while the concept of common trends describes convergence to a fixed but non-unitary ratio in growth rates. If incomes follow a stochastic trend (unit root process), convergence (or common trends) is confirmed by the finding of a cointegration relationship between the time series. This convergence is referred to as *stochastic convergence*.[21] If incomes are described by a deterministic trend, then convergence (or common trends) is confirmed by the finding of a uniform trend. This convergence is referred to as *deterministic*

[21] The difference between convergence in output and common trends in output is that, for convergence in output, the coefficients for all output variables in the cointegration have a value of one, while the coefficients are not equal to one (meaning either greater than or less than one) in the case of common trends.

convergence.[22] Bernard and Durlauf (1995, 1996) argue that, in fact, β-convergence is a more restricted measure that can actually be referred to as *catching up* where (in the bivariate case):

$$\lim_{k\to\infty} E\left(y_{i,t+T} - y_{j,t+T} \middle| I_t\right) < y_{i,t} - y_{j,t} \qquad for\ y_{i,t} > y_{j,t}$$

Testing for time series convergence among a small group of countries/regions can be relatively straightforward but testing for such convergence among a large group of countries/regions can quickly become an unwieldy exercise. Direct cointegration techniques are not practical for large groups of countries. Using a benchmark country or region (to which other countries are assumed to converge), by necessity, imposes a prior restriction that may or may not be justified by the data. Testing for all pairs of output series for evidence of convergence can make it a tedious procedure with results whose interpretation is not straightforward (see Islam, 2003 and Pesaran, 2007). In Chapter 3 of this dissertation, this method is applied because of the small number of regions and the strong theoretical and historical justification for defining a core region but it is not employed in later investigations of intra-regional convergence.

2.4.4 Relevant Measures of Club Convergence

At a broader level, when faced with a multiplicity of countries or regions (as against pairs of countries or regions), all of these concepts of convergence are restrictive when applied in a universal sense because they imply an all-or-nothing proposition. Implicit in

[22] For the case where output series follow deterministic trends, convergence in output and common trends would be differentiated by the existence of non-zero difference in output series after the trend is accounted for (common trends) and a zero difference (convergence in output).

those measures is the presumption that the relevant forces of convergence apply to all countries in a sufficiently uniform manner to lead to a single long-run equilibrium (in output or growth). When dealing with a large group of countries with different histories, different structures, and differing degrees of economic interaction this is a tall order and, from early on, researchers recognized that less all-encompassing concepts might be more appropriate. Baumol (1986) noted that advanced industrialized countries and centrally planned economies (of that time) appeared to form separate convergence "clubs" with no indication of convergence among the remaining countries. Quah (1996: 1050) described this phenomenon more formally as: "sub-groups or clubs forming, with member countries converging towards each other, and diverging away from different clubs." The concept of club-convergence has the advantage of allowing for differences in country types as well as initial conditions in searching for convergence. More recent measures have sought to endogenize club membership by allowing the different clubs to be determined by the data itself rather than being imposed based on specific criteria (Phillips and Sul, 2007).

There is no single measure of club convergence. In fact, with a few exceptions, the various measures used to identify club convergence are often the same measures used to detect universal convergence. Baumol (1986), for example, used a β-convergence measure (together with scatter plots) on cross-section data to identify convergence clubs. Quah (1996) focused on the nature of the distribution of income and its evolution – interpreting club convergence from its tendency to dual or multiple modes. Durlauf and Johnson (1995) used panel data in trying to identify convergence clubs while Phillip and Sul (2007) developed a distribution-based measure (the log t test) that can be applied within a time series framework.

In the empirical investigations reported in the succeeding chapters of this dissertation, the σ-convergence, stochastic convergence, and log t (club convergence) tests will be employed. The first is chosen because of its ease of interpretation as well as its close relationship to what can be considered a foundational understanding of convergence. The second is chosen because it allows closer examination of each developing region relative to the core region. The third can be seen as an improvement on both the σ-convergence and β-convergence measures. It retains the distribution of incomes as the functional parameter but attempts to go beyond transitional dynamics to identify long-term trends. It is also less restrictive than β-convergence as it allows for, and endogenizes, club convergence as a likely result. Furthermore, it is relatively straightforward in both implementation and interpretation compared to other time series methods. Despite the flexibility it offers it is not any simpler in conception.

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CHAPTER 3: DOES GLOBALIZATION HAVE INTER-REGIONAL CONVERGENCE IMPLICATIONS?

This chapter incorporates material that is the result of joint research with Dr. John Serieux. The author of this thesis had responsibility for writing and statistical analyses while the co-author proposed the general idea and provided advice and reviews. In line with the overall thesis, this chapter is essentially a stand-alone piece with its own abstract, introduction, conclusion and references.

ABSTRACT

The focus of this chapter is in two parts: first, a multi-dimensional examination of the evolution of per capita output differentials between North America (a designated core region) and nine world regions (designated peripheral regions) since 1970 and, secondly, an investigation into the relationship between the movements of the output differentials and globalizing flows since 1990. The examination suggests that no peripheral region can be said to have experienced true *stochastic convergence in output* toward the core region since 1970 but all regions demonstrated a *common trend in output* with the core region. Two regions (The Pacific Region and Western Europe) have common trends that approach unity and can thus be described as demonstrating near-convergence. Compared to the first group, a second group of regions have relatively weak but still large common trend coefficients – suggesting an inner periphery status of middle income regions. A third group of regions have moderate common trend coefficients that suggest outer periphery status. With respect to the effect of globalizing flows on regional output differentials, none of them

were shown to be significantly associated with changes in regional output differentials. The factors strongly associated with changes in the regional output differential were the differential in regional investment rates and global commodity price indices (relative prices of fuel and non-fuel commodities to manufacture goods).

3.1 INTRODUCTION

Globalization is generally accepted as a phenomenon of the late 20th and early 21st century. If we accept the International Monetary Fund's (2000: 2) definition of economic globalization as: "The increasing integration of economies around the world, particularly through trade and financial flows…[and] the movement of people (labor) and knowledge (technology) across international borders" it would be hard to argue that there is no substantive evidence of globalization. However, that definition also suggests that globalization is the consequence of the expanding magnitudes of economic variables that are known to have real economic implications at the country level – suggesting that this phenomenon can be expected to have real growth and human development consequences.

In the extensive, and still growing, literature on inter-country convergence, it is typically argued that convergence (or divergence) is the consequence of (some combination of) the diffusion of technology, financial flows, trade flows, or migration flows. Since these are precisely the flows that have brought about globalization it would seem to follow, at a theoretical level at least, that globalization should have convergence (or divergence) implications. Moreover, if globalization has not been uniform across world

regions its convergence (or divergence) implications also need not be uniform across these regions.

This essay seeks to expand both the convergence and globalization literature by examining the pattern of convergence/divergence between world regions and the role of globalizing flows in that regard. This investigation will be carried out in two stages. In the first stage, ten world regions will be defined and three tests of convergence (sigma-convergence, pair-wise convergence and log-t convergence tests) will be used to determine whether (and, if so, which) world regions have moved closer together or apart since 1970. In particular, movements relative to the designated core region of North America will be examined. In the second stage, the relationship of such movements to particular globalizing flows, together with other variables expected to have effects on convergence, will be investigated using panel data regression analysis. The latter examination will cover only the last two decades – a period over which there has been broad consensus about globalization as a generalized phenomenon and for which data is available for all regions.[23]

In that regard, in the next section we present alternative theoretical perspectives on globalization and convergence and pervious empirical work in that area. This is followed (in Section 3) by a presentation of the methodological approaches to be employed in the investigation of inter-regional convergence and determinants of inter-regional income gaps. Section 4 presents the results from the analyses of regional convergence patterns and the

[23] Previous to that period almost none of the relevant data is available for Eastern Europe and Central Asia.

effects of globalizing flows on the differences in regional incomes. Section 5 concludes the chapter.

3.2 ALTERNATIVE PERSPECTIVES ON GLOBALIZATION AND CONVERGENCE

3.2.1 The Theoretical Literature

Perspectives on the relationship between globalization (using the IMF definition) and inter-country output convergence vary both across and within theoretical perspectives. There are almost no theoretical models that specifically address inter-regional convergence but, as pointed out in Chapter 2, inter-regional implication can often be deduced from models that address inter-country output differential though not always. Among static theories, neoclassical models generally imply that globalizing flows tend to promote inter-regional output convergence. However, even within that paradigm there are voices that argue that under certain conditions, such as slow rates of capital formation in developing countries (Choi, 2004), imperfect competition (Melitz, 2003), or insufficient levels of human capital (Borensztein *et al.,* 1998), globalizing flows will not promote convergence and may even result in divergence. Structuralist models generally suggest divergence as the most likely consequence of globalization but, among these theories as well, certain types of flows, such as unskilled labour migration (Jennissen, 2007), may induce convergence.

Among dynamic (growth) theories, various paradigmatic frameworks also differ in their typical prediction with respect to the effect of globalizing flows on inter-country and, by extension, inter-regional convergence. In this case as well, predictions are not always

uniform within paradigmatic approaches. For instance, open economy neoclassical models generally indicate convergence as the most likely consequence of globalization. On the other hand, endogenous growth models are non-uniform in their (implied) predictions about the effects of globalizing flows. Endogenous models indicate that both convergence and divergence are possible but the absence of any persistent or generalized pattern of change in inter-regional outputs is seen as the more likely outcome. The earliest structuralist growth models uniformly predicted divergence as the consequence of increased trade, finance and technology flows between countries and regions (Myrdal, 1957; Prebisch, 1950; Singer, 1949; Wallerstein, 1974) but later structuralist North-South growth models have allowed the potential for growth convergence (Botta, 2009; Burgstaller and Saavedra-Rivano, 1984).

3.2.2 The Empirical Literature on Inter-Regional Convergence

Though studies of convergence between countries and between different parts of a country (or larger contiguous geographic areas) are common, studies of convergence between world regions are rare. Mathur (2003) tests for convergence among selected regions (sixteen European countries, eight East Asian countries and five South Asian countries) for the period 1961 to 2001. He tests for evidence of inter-country β convergence across those regional groupings and finds evidence of conditional convergence when all countries are considered and when the European Union countries are combined with the countries of East Asia or South Asia but not when the sample is composed of only East and South Asian countries. There is a strong likelihood that these results are driven by the fact that, as a group, the much richer European Union countries

had a slower growth rate (over that period) than the developing countries in South and East Asia while the patterns of growth within those regions did not negatively correlate with initial output levels. This would, in fact, suggest inter-regional convergence (in accordance with the concept of β-convergence) but, given the study design (regions are not treated as single entities), this result is more implicit than explicit.

Zhao and Serieux (2012), sought to determine whether the region of South America had converged to the core regions of the world during the post-Bretton woods era (where the core region was alternatively defined as North America and Western Europe combined). Applying time series convergence tests, they found that the difference series for the purchasing-power-parity denominated output of South America and the core were level stationary for the period 1990 to 2008 – implying convergence (or, more strictly, non-divergence, for that period). There was no support for convergence when outputs were denominated in US dollars or when longer or earlier time periods were used. The authors also found that the three variables with the strongest influence on inter-regional output differences over that period were: the investment-rate differential (between South America and the core region), the global commodity price index, and the proportion of high-technology goods in total regional exports.

3.3 METHODOLOGY AND DATA

3.3.1 Choice of Convergence Tests

3.3.1.1 Sigma Convergence Tests

To establish the general context, in terms of the evolution of regional outputs, we are interested in the pattern of dispersion of regional outputs since the end of the Bretton

Woods era. A systematic decrease in the dispersion of country outputs is referred to as sigma convergence across countries. The same is true of global regions. Such a decrease (in dispersion) is typically equated with a declining standard deviation of the log of per capita outputs across countries. By contrast, an expanding standard deviation would suggest divergence. For this investigation, we calculate the natural logarithm of per capita output for each region. We then plot the standard deviation of the series for 1970 to 2011 on a graph. We also plot the standard deviation of the trend element of these outputs after applying the Hodrick-Prescott filter to the data. If the hypothesis of sigma convergence, for all regions combined, is true, we would expect to see a persistent downward trend in the series. If instead, divergence is occurring, for all of that period, then we would expect to see a persistent upward trend. Of course, it is also possible to find that there are no discernible trends, or that there are shifts in trends over time.

3.3.1.2 Tests of Pair-wise Convergence

As noted in Chapter 2, Bernard and Durlauf (1995) introduced the concept of time series convergence between two countries in the form of: (1) *convergence in output,* where, given log per capita output (y), for countries i and j at some fixed time period t, and current information (I_t):

$$\lim_{k\to\infty} E\left(y_{i,t+k} - y_{j,t+k} \middle| I_t\right) = 0\,; \tag{1}$$

and (2) a *common trend in output*

$$\lim_{k\to\infty} E\left(y_{i,t+k} - \mu y_{j,t+k} \middle| I_t\right) = 0. \tag{2}$$

Both concepts of convergence imply a cointegrating relationship between the per capita output measures. However, both convergence and common trend in output are quite restrictive definitions because they apply only when the process of convergence is complete or far advanced. There is a little room for the transitional dynamics that might apply well before convergence is complete. One of these transitional processes, akin to the *β-convergence* associated with cross-section analysis, is described by Bernard and Darlauf (1995), as catching-up. More formally, a lower output country (or region) *i* is *catching-up* to a higher-output country (or region j) between dates t and t+T if:

$$\lim_{T\to\infty} E\left(y_{j,t+T} - y_{i,t+T} \middle| I_t\right) < \quad y_{j,t} - y_{i,t} \tag{3}$$

It might appear at first that, with respect to regional convergence, the potential presence of pair-wise convergence (or lack thereof) can be initially determined by implementing unit root tests to the differential of the log of regional per capita outputs (as suggested by Pesaran (2007)).[24] However, such a test cannot fully distinguish among convergence in output, a common trend in output, and divergence. For instance, the presence of a common trend can lead to either acceptance or rejection of a null hypothesis of non-stationarity for the regional output differential (depending on the size of μ).

However, by generalizing Bernard and Durlauf's (1995) definition of a common trend (equation 2), we can develop a specification (equation 4, bellow) that can be estimated and can distinguish a common trend from convergence/divergence. Moreover,

[24] Regional per capita outputs are measured as the total regional output divided by the total regional population. It is, therefore, a weighted, rather than simple, average.

that specification can also be used to detect the presence of a residual difference in incomes ($\alpha \neq 0$) and/or the presence a transitory catching up or divergence process ($\beta \neq 0$) even after convergence or a common trend has been accounted for. According to Bernard and Durlauf's (1995) definition, a common trend will exist only when the error term ϵ_t of equation 4 is stationary.

$$\left(y_{p,t} - \mu_{pq} y_{q,t}\right) = \epsilon_t \tag{4}$$

For econometric analysis, a stationary error term can be decomposed into several components (as in the Dickey Fuller equation). The most general form usually considered consists of a constant term, a trend, and a white noise process. Therefore, given two regions p and q, equation 4 can be generalized as follows:

$$\begin{aligned} \left(y_{p,t} - \mu_{pq} y_{q,t}\right) &= \alpha_{pq} + \beta_{pq} t + \varepsilon_{pq,t} \\ y_{p,t} &= \alpha_{pq} + \beta_{pq} t + \mu_{pq} y_{q,t} + \varepsilon_{pq,t} \end{aligned} \tag{5}$$

If the modified output differential $(y_{p,t} - \mu_{pq} y_{q,t})$ is non-stationary (ε_{pq} is not I(0)) (regardless of the values of μ_{pq}), then (stochastic) divergence (or, more conservatively, non-convergence and no common trend) between regions is the obvious conclusion. If stationarity obtains (ε_{pq} is I(0)) and $\mu_{pq}=1$, $\alpha_{pq}=0$, $\beta_{pq}=0$ then a [1, -1] vector describes the cointegrating relationship and, therefore, stochastic convergence (in the Burnard and Durlauf (1995) sense) is the obvious conclusion. This is also the strongest form of (stochastic) convergence because it indicates convergence in levels of output. However, if strict stationarity obtains (ε_{pq} is I(0), $\alpha_{pq}=0$, $\beta_{pq}=0$) but $\mu_{pq} \neq 1$, the regions share a common trend in output (It is notable that a straightforward test for the stationarity of pair-wise

differentials ($y_{p,t} - y_{q,t}$) would lead to rejection unless μ was close to one). If stationarity obtains (ε_{pq} is I(0)) and μ_q=1, $\alpha_{pq}\neq 0$, β_{pq} =0 then stochastic convergence still obtains but there is a constant in the cointegrating relationship. This condition holds when the two regions have converged (or nearly converged) in growth rates but retain a permanent differential in output.[25] If ε_{pq} is I(0), $\mu_q \leq 1$, α_{pq}=0 but $\beta_{pq} \neq 0$ then trend stationarity obtains (in the presence of convergence or common trend).[26] This would meet the criteria for the catching-up condition if $\beta_{pq} > 0$ for $y_q > y_p$, (or trend convergence which, as noted above, is the corollary of β convergence) but trend divergence if $\beta_{pq} < 0$ for $y_q > y_p$. Therefore a finding of a positive trend (assuming trend stationarity) can be interpreted as evidence of transitional catch-up between regions (over the period covered by the sample) but a finding of a negative trend in that regard can be considered evidence of divergence. In general, convergence and common trends can be seen as long-term relationships that map out the co-evolution of regions. By contrast, trend convergence (catching up) can be seen as part of the transition dynamics relating to the convergence (or divergence) process, or even to temporary phenomenon, rather than the achievement of long-run convergence itself.

In order to determine which of these results (or which combination) obtain for relevant regional pairs, a range of tests and estimation procedures were required. The first requirement was a determination of the level of integration of each regional output series. To do so, we applied two types of unit root test to the relevant series. The first test

[25] In the lexicon of the neoclassical model, this would mean different steady states but similar technology-driven growth rates.

[26] This condition could still be relevant even if one or both of the (log) output variables were trend stationary.

suggested by Kwiatkowski *et al* (1992) (henceforth the KPSS test) has a null of stationarity and is better than most tests at distinguishing between persistent (near unit root) but stationary processes and unit root processes (Lee and Schmidt, 1996). The second test, the Generalized Least Squares (GLS) version of the Dickey-Fuller test developed by Elliot, G. *et al* (1996) (henceforth the DF-GLS test) has a null of non-stationarity and has high power in small samples (Elliot, G. *et al*, 1996). In this essay, a series is accepted as unambiguously level stationary if the KPSS does not reject the null hypothesis (of stationarity) *and* the DF-GLS rejects the null (of non-stationarity) at the five percent level or better – meaning that the two tests are in agreement. Unambiguous non-stationarity derived from the opposite results. Ambiguous results are interpreted in favour of the DF-GLS test because of its stronger small-sample properties. All the (log) regional per capita income estimates were found to follow non-stationary I (1) process.

In the empirical literature, pair-wise convergence has usually been applied with respect to a reference (leader) country.[27] At the level of global regions, concern about convergence (or divergence) between regions generally relates to the relationship between the most advanced and least advanced regions. This makes the core-periphery model an appropriate framework for the application of pair-wise comparisons. Myrdal's definition of the "core" region of the world economy as the grouping of: "rich countries marked by the high "quality" and "effectiveness" of their factors of production" (Myrdal, 1957: 51) would

[27] Pesaran (2007) suggests applying the convergence tests to all pairs of countries (in our case regions) and determining overall convergence by the proportion of pairs that meet the convergence criteria. This option is less appropriate here because the log t test will do essentially the same thing in a more straightforward way. Also, we are in fact mostly interested in the relationship between the relationship between the less advanced regions and most (economically) advanced region.

seem to apply quite readily to the region of North America (consisting of the economies of the United States and Canada). That region includes the world's largest economy and another G7 country, Canada. Western Europe is also a region dominated by a large number of highly productive (as well as highly integrated) economies with strong global economic influence. That region, too, could fit Myrdal's definition of a core region but we are also interested in the relationship between Western Europe and North America, which has a higher average per capita output level. We shall therefore limit the analysis to one core region. All regions, besides North America, are assigned peripheral status (as the framework requires); we leave it to the empirical results to suggest otherwise.[28] Therefore, using pair-wise analysis, each region was compared to the core region of North America.

Since the recognition of cointegration as a theoretically valid (and statistically information-conserving) approach to estimating long-run relationships between non-stationary variables in the 1980s, several approaches have been developed for estimating the cointegrating relationship between two (or more) variables. These can be classified into three main groups: error-correction models, single-equation models (such as fully modified ordinary least squares (FMOLS), dynamic ordinary least square (DOLS) and canonical correlation regression (CCR)) and the systems-based approach (of which the Johansen method is the best known (Johansen 1988)).[29] The model specified above does not lend itself to the error-correction framework. The systems-based approach is most

[28] If any region is found to demonstrate strong stochastic convergence to North America, it would have to be considered part of a conglomerate of core regions (along with North America).

[29] The ARDL method applied in the following chapters can be treated as a separate approach but it is probably more correctly treated as a variant of the error correction approach.

advantageous when there are, potentially, more than one cointegrating equation and where the precise nature of the cointegating equation is not pre-determined by theory. This is not the case here, where there can only be one cointegrating relationship between the two non-stationary variables and where the nature of the cointegrating relationship is well specified by theory. We therefore estimate equation 4 using a single equation approach, specifically, using the FMOLS model (built in the STATA 12 statistical package).[30]

FMOLS was originally designed by Phillips and Hansen (1990) to estimate a cointegrating relationship. Specifically, FMOLS models provide hyper-consistent estimates by modifying least squares to account for serial correlation and endogeneity effects from the existence of non-stationarity. Montalvo (1995) compares a FMOLS estimator with the other two single equation estimators (DOLS and CCR) and concludes both DOLS and CCR have better finite sample performance than FMOLS. Pedroni (2000) argues that DOLS could be a better option only for small samples otherwise FMOLS would provide a more robust estimation. It is notable and encouraging, that in our study the two other single-equation approaches (DOLS and CCR) generally produced identical results to FMOLS.

A cointegrating relationship is established when the error term (ε) from the estimated equation 5 can be shown to be stationary (by both KPSS and DF-GLS tests). Following the approach of Ayala *et al* (2012), if the modified output differential was not found to be stationary using the KPSS and DF-GLS tests of the errors term in the basic FMOLS specification (from equation 5), we applied tests for structural breaks in the time

[30] This is one of three approaches available through COINTREG in STATA 12;

series using the approach suggested by Clemente, Montanes and Reyes (1998). If such a break was found (in the output differential), then the trend and drift (constant) terms in the FMOLS equation were adjusted to reflect the structural break (as appropriate to ensure that the ε_t was stationary and, therefore, the FMOLS represented a cointegrating relationship). It turns out that all modified output differentials were found to be stationary when two structural breaks were accounted for.

In such a cointegrating relationship, in keeping with the discussion above, α=0, β=0 and μ=1 is interpreted as evidence of stochastic convergence in the strongest sense (convergence in output levels) with no transition dynamics. If $\alpha \neq 0$, β=0 and μ=1 then we have a weaker form of stochastic convergence – convergence in rates of growth (with no transition dynamics). If α=0, β=0 and $\mu<1$ then the conclusion is that these regions share a common trend but have not converged. If α=0 and $\beta>0$, (when $\mu \leq 1$) then the peripheral region can be seen catching-up to the core region over the sample period (in the presence of a long-term common trend in output or convergence). If α=0 and $\beta<0$ (when $\mu \leq 1$) then the peripheral region has been diverging from the core region over the sample period (regardless of the fact that the regions share a common trend or even convergence in output). If $\alpha \neq 0$ but β=0, in the presence of convergence or a common trend ($\mu \leq 1$), a differential is expected to persist in incomes. If $\alpha \neq 0$ in the presence of a trend in output ($\beta \neq 0$) the meaning is less obvious. Given that a common trend need not mean convergence and can be consistent with persistently diverging incomes over the long run, the importance of a finding of a persistent gap in output will depend on the size of the common trend. Such a gap may have some meaning if the common trend value suggests near

convergence (μ approaches one) but may add or subtract very little if the common trend is weak (μ not close to one).

3.3.1.3 The Log t Test

Following Phillips and Sul (2007), the logarithm of the per capita GDP for region *i* at time period *t*, $logy_{it}$, can be written as:

$$logy_{it} = \delta_{it}\mu_t \tag{6}$$

In the above equation, $\mu_t$is the common growth path and δ_{it} represents the share of the common growth path that country *i* undergoes.

In order to specify the null hypothesis of convergence, Phillips and Sul (2007) further decompose δ_{it} into two parts:

$$\delta_{it} = \delta_i + \frac{\sigma_i \xi_{it}}{L(t)t^{\alpha}} \tag{7}$$

Where δ_i does not vary over time, σ_i denotes country-specific parameter, ξ_{it} is an *iid* (0,1) random variable, L(t) is a slowly varying function *(*such that $L(t) \to \infty$ as $t \to \infty$*)* and α is the decay rate[31].

The null and alternative hypotheses of convergence can be written as:

H_0 : $\delta_i = \delta$ for all *i* and $\alpha \geq 0$

H_A : $\delta_i \neq \delta$ for all *i* or $\alpha < 0$

[31] Here the slowly varying function ensures that convergence may occur even if the decay rate is zero.

Under the null hypothesis of convergence, long run convergence can be reached through different transitional paths, including catch up, common trend, or even temporary divergence, which refers to periods when $\delta_{it} \neq \delta_{jt}$.

The relative transitional coefficient for country i at time period t, h_{it}, represents the transitional path of country i relative to the cross section average.

$$h_{it} = \frac{logy_{it}}{N^{-1}\sum_{i=1}^{N} logy_{it}} = \frac{\delta_{it}}{N^{-1}\sum_{i=1}^{N} \delta_{it}} \quad (8)$$

The cross-sectional variance of h_{it}, denoted by V_t^2

$$V_t^2 = N^{-1}\sum_i (h_{it} - 1)^2 \quad (9)$$

In the case of convergence, all countries move toward a common path, $h_{it} = 1$ for all i, as $t \to \infty$, and V_t^2 converges to zero as $t \to \infty$. In the case of no overall convergence, there are a number of possible outcomes for V_t^2. It may converge to a positive number, which is the case for club convergence, or remain positive but not converge to any number (which rejects the existence of convergence clubs), or explosively diverge.

Substituting δ_{it} by $\delta_i + \frac{\sigma_i \xi_{it}}{L(t)t^{\alpha}}$ in equation (8), Phillips and Sul (2007) show that under convergence, V_t^2 will satisfy the following condition:

$$V_t^2 \sim \frac{A}{L(t)^2 t^{2\alpha}} \qquad \text{as } t \to \infty \text{ for } A > 0 \quad (10)$$

From equation (10), Phillips and Sul (2007), starting with the cross-sectional variance ratio (V_1^2/V_t^2), taking logs, and rearranging terms, specify the following equation from which the log t convergence test can be derived:

$$\log \frac{V_1^2}{V_t^2} - 2 \log L(t) = c + b \log t + \mu_t \quad (11)$$

$$t = rT, rT+1, ..., T \text{ for } r \in (0,1)$$

Here -2logL(t) is a penalty term and c refers to a constant term. Under the null of convergence, the estimate of the parameter b is 2α (here α represents the decay rate as we mentioned before). According to Phillips and Sul (2009), the role of the penalty term is to improve the test's discriminatory power between overall convergence and club convergence. The condition $r \in (0,1)$ ensures that the first r% of time series data is discarded. This data trimming focuses the test on the latter part of the sample data and helps to validate the regression equation in terms of the tendency to converge.

Based on Monte Carlo results, Phillips and Sul (2007) suggest L (t) = log t and r = 0.3 for sample sizes below T = 50. Then, using $b = 2\alpha$, they suggest a one-sided t-test for the null hypothesis $\alpha \geq 0$. The null hypothesis of convergence is rejected if $t_{\hat{b}} < -1.65$ at the 5% significance level.

Before applying log t convergence test, we first filter the data to remove the effects of the business cycle using the Hodrick-Prescott smoothing filter, as suggested by Phillips and Sul (2007). If convergence is rejected for the overall sample, the four step clustering test procedure will be applied to subgroups of regions to identify the existence of convergence clubs (as suggested by Bartkowska and Riedl 2012):

- First, sort the real per capita GDP of all countries in descending order.
- Second, identify the first convergence club by grouping the first two richest countries in the region and then use the log t test to determine whether they belong

to a convergence club and continually add more countries to the group as long as the null hypothesis is not rejected.

- Third, conduct the log t tests between group members and remaining countries in the sample one by one to check if some of the group members are involved in two or more convergence clubs.
- In the final step, the first three steps are applied to the remaining countries to check if some of these countries are converging to their own clubs or simply diverging from each other.

The log t test procedure has been programed in Matlab by Bartkowska and Riedl, and the codes are applied in this chapter with permission.

3.3.2 Analyzing Potential Determinants of the Output Differential

3.3.2.1 Study Variables

The models presented above (and in Chapter 2) argue that globalizing variables will have measurable, but different, effects on the outputs of countries in the core and peripheral regions, thus resulting in positive or negative changes in the output gaps between the peripheral and core regions. There are other variables, not particularly related to globalization, but which theoretical growth models (neoclassical and endogenous growth models) expect to have similar effects on the outputs of countries in both the core and peripheral regions. Therefore the relative values of these variables between the peripheral and the core regions can have significant effects on output gaps. These variables include physical capital investment, labour-force growth and human capital formation. We

can reasonably expect that faster growth of these variables in the peripheral regions (relative to the core) will generate an impetus toward convergence while the opposite would favour divergence.[32] In addition, as noted in Chapter 2, structuralist models (beginning with the Prebisch-Singer hypothesis) argue that the relative prices of primary and manufactured products will affect the rate at which peripheral countries converge to (or diverge from) core countries. We can presume that, if this is the case, it would be true for regions as well as countries. Therefore, the average price of primary commodities (both fuel and non-fuel products) relative to the average price of manufactured goods is a potential explanatory variable for the output gap between peripheral regions and the core.

3.3.2.2 The Regression Model and Technique

The presumptions above were used to develop and estimate an econometric equation (equation 12) in which the dependent variable is the (log) output differential between each peripheral region (p) and the core region of North America (c). The right hand side of the equation constitutes globalizing flows (G) - trade flows, foreign direct investment flows, portfolio flows, and the export of high technology goods by peripheral regions[33]. The first three variables are relative to regional incomes and the last relative to total exports.[34,35] To these are added growth-related regional factors (R) - the investment

[32] We should stress, however, that this is a likely not a necessary result because of the possibility that the growth impact of these variable can (and do) vary across countries and, presumably, regions. Even when the effect of all other variables are taken into account, the same rate of investment in two countries (or regions) need not result in identical growth rate due to structural and institutional differences.

[33] Migration flows were not included because of data limitations.

[34] The export of high technology goods proxies for technology flows. This derives from the presumption that countries (and, therefore, regions) can only export high technology goods if they have advanced significantly up the technology ladder.

[35] A fifth globalizing variable, migration, is not included because of insufficient time series data on migration flows

rate differential between the peripheral region and the core region, the differential between labour force growth in the peripheral region and that in the core region, and the differential between the secondary school enrollment rates in the peripheral region and the core region.[36] The third type of right-hand-side variable (S) - motivated by structural perspectives – is the differential between global commodity prices indices and the (global) manufactures unit value index.[37]

$$(y_{ct} - y_{pt}) = c + \alpha(y_{ct-1} - y_{pt-1}) + \beta Gt + \gamma Rt + \delta St + \varepsilon t \qquad (12)$$

This analysis spans the two decades from 1990 to 2011. The most immediate reason for choosing this sample period was data limitations (two of the regions, Central Asia and Eastern Europe, do not have useful data before that period).[38] Beyond this constraint, however, there is some merit to limiting the analysis to the period from 1990 onward because its description as a period of relatively rapid globalization is not controversial. Though many investigators date the commencement of this latest period of globalization to the early 1970s and others to the early 1980s, these dates remain contested. There is significantly more consensus that the period since the 1990s has been one of increasing globalization. The panel data set that resulted from the number of peripheral regions (nine) and the number of years (22) meant that we were dealing with a narrow and only moderately long panel data set (small N, modest T). For this study, the nature of the

[36] A less restrictive version of this equation would allow the periphery and core-related variables to enter the equation separately. However, the cost in terms of degrees of freedom would be too high for such a small data set. In any case, when these variables were included separately they did not improve equation performance.

[37] The commodity price index is produced by the International Monetary Fund (International Financial Statistics) and the manufactures unit value index (MUV) is produced by the World Bank (GEM Commodities). The latter index (MUV) is a composite index of prices for manufactured exports from the fifteen major developed and emerging economies to low- and middle-income economies.

[38] Data on technology flows are also limited before 1990.

dependent variable (the inter-regional per-capita income differential) suggests that it is a long-memory variable and a finding of autocorrelation in linear estimates of the equation confirmed that presumption.[39] This suggests that the appropriate specification should be a dynamic model. Moreover, the likelihood that there are missing or unobserved variables that would be highly region-specific motivates a fixed-effects panel model (e.g. least squares dummy variable model (LSDV)). However, Nickell (1981) noted that the bias (in coefficient estimates) that is inherent in such a model could be quite large in panel data sets with finite T. Since then, several estimation methods have been developed to deal with the small sample bias in dynamic panel data models, they are Anderson-Hsiao's (1982) IV, Arelliano-Bond's (1991) AB-GMM and Blundell–Bond's (1998) BB-GMM and Kiviet's (1995 and 1998) bias corrected LSDV (later we call it LSDVC) estimation procedures (Bruno, 2005). Among them, the Anderson-Hsiao's IV estimator and the Kiviet's LSDVC estimator are applied to narrow (small N) panel date sets (Judson & Owen, 1996). Anderson and Hsiao (1982) correct the bias by first differencing all variables and using the second and/or third (differenced) lags of the dependent variable to instrument for the first (differenced) lagged dependent variable. Kiviet (1995 and 1998) uses a different experimental design to include terms of at most order $N^{-1}T^{-2}$.[40] Using Monte Carlo simulations, Judson and Owen (1996) evaluate the small sample performance of the Anderson-Hsiao's IV estimator in comparison to those of the original LSDV and the bias corrected LSDVC estimators. The

[39] An XTSERIAL regression of the linear equation produced test statistics (Wald Tests) that strongly rejected the null hypothesis of no (first order) serial correlation in the residuals (as well as a rejection of no second-order autocorrelation).

[40] Kiviet (1995) uses higher order asymptotic expansion technique to approximate the small sample bias of the original LSDV estimator.

result shows that the bias corrected LSDVC estimator performs well for panels with small time dimensions while the Anderson-Hsiao (first difference) estimator offers the best bias reduction for narrow panels with moderate T. We therefore estimate equation (12) as a dynamic model with fixed effects using the Anderson-Hsiao (first-differenced) estimation method.

Before estimating the equation, we implemented panel unit root tests to determine the level of integration of the right-hand-side variables.[41] The tests implemented were the Lavin-Lin-Chu and the Im-Pesaran-Shin tests for the true panel variables and the DFGLS and KPSS tests for the price index variables (which are not country specific, and therefore, not true panel variables). As Table A3.1 (Appendix) indicates, all of the right-hand-side variables were found to be stationary.[42]

Since the Anderson–Hsiao (AH) estimation procedure has been implemented by the Stata command xtivreg, estimating work could be straightforward. However, it should be noted that the initial test for autocorrelation found second-order as well as first-order correlation. We attempted additional correction (beyond that provided by the simple first difference estimator) by adding the (differenced) second lag of the dependent variable to the regression (and using only the (differenced) third lag as an instrument)[43] but the

[41] We have previously established, from the pair-wise convergence tests, that the dependent variables are stationary (though sometimes with structural breaks).
[42] The results from the price index variables are contradictory (the DFGLS test rejected non-stationarity while the KPSS test rejected stationarity). However, we gave greater credibility to the DFGLS test because it has been shown to be offer better results in small samples (Elliot, G. *et al*. 1996). Further, line graphs of the variables did not suggest a random walk, rather there was a dip in the 1990s and a rise in the 2000s.
[43] This is an acceptable option because Anderson & Hsiao (1982) showed that that variable is not correlated with the error term hence the suggestion that it be used as an instrument.

coefficient for that lag was always insignificant so it was dropped from the regression and used as an instrument instead.

To check for the specification of the regression equation, we applied two identification tests after regression. Anderson Canonical Correlation LM Statistic test was used to check for the existence of under identification while the Sargan test for over identification was applied to test for the validity of instrument variables.

3.3.3 Data and Sources

Since most potential determinants of income distribution are measured in US dollar, for consistency, there is a need to use US dollar as a measurement of per capita income. However, the measurement with US dollar is subject to the fluctuation of market exchange rates. Another drawback of the US dollar measurement is that market exchange rates are relevant only for internationally traded goods (Callen, 2007). Usually the prices of nontraded goods are higher in developed countries than emerging and developing countries. Therefore the US dollar measurement is likely to overestimate the welfare of high income countries and underestimate that of low income countries. The measurement of per capita income with international dollar is based on the exchange rates derived from Purchasing Power Parity (PPP). The PPP based exchange rates are good at catching the differences in the prices of non-traded goods across countries (Callen, 2007). In addition, using international dollar to measure per capita income can minimize misleading comparisons that may arise with the fluctuation of market exchange rates. However, the PPP based exchange rate has its own weaknesses. The major one is the inaccuracies related

to its measurement. PPP rates are generated by the International Comparisons Program (ICP), based on a global survey of prices (Callen, 2007). Since survey data are available only in benchmark years, in the years between, the PPP rates have to be extrapolated by varies methodologies. Also, the ICP's survey does not cover all countries, which means that data for missing countries need to be estimated. Therefore, the two forms of measurements are likely to complement each other since they have different types of weaknesses.

In this study, all income variables are measured as nominal GDP per capita using both international (PPP) and US dollars respectively. The data on income in international dollars are derived from the Penn World Table 8.0(International Comparison of Prices Program, University of Pennsylvania). The data on income in US dollars are derived from the United Nation Data (UN data 2014). The data for other variables come from a variety of datasets produced by the International Monetary Fund, the OECD, the World Bank and the United Nations. All of the dependent and potential independent variables and corresponding data sources are listed in appendix table A5.

3.4 RESULTS AND ANALYSIS

3.4.1 Globalization and Convergence – Regional Analyses

3.4.1.1 Evidence and Patterns of Globalization

Though globalization is generally an accepted phenomenon, its cross-regional variation is not well documented. Table 3-1 (below) indicates data on globalizing flows at the level of world regions - presuming the International Monetary Fund's (IMF) definition

of globalization.[44] More precisely, the table records the percentage point difference in trade, foreign direct investment (FDI) and portfolio investment ratios between each of the last three decades and the (relevant) previous decade and the difference in high technology exports (as a percentage of merchandise exports) between the last decade and the previous decade.[45] The figures indicate remarkably few instances of decline or stagnation in the relevant ratios. For all regions, the majority of these globalizing flows (relative to output or merchandise exports) increased in both the 1990s and 2000s. However, the magnitude of these increases varied widely across world regions. Based on the magnitude of the recorded changes and degree of universality, the most rapidly and thoroughly globalizing regions would appear to have been East Asia, South Asia and Western Europe.

[44] See Table A1 of the appendix for the descriptions of the ten world regions.

[45] High technology exports proxies for the level of absorption of technology since it is presumed that countries can only export high technology goods if there has been substantial movement along the technology gradient. The figures presented are restricted to the last decade because of data limitations. Migration flows were not included because of data limitations as well.

Table 3- 1: Globalizing Flows across Regions (% Increase over Previous Decade)

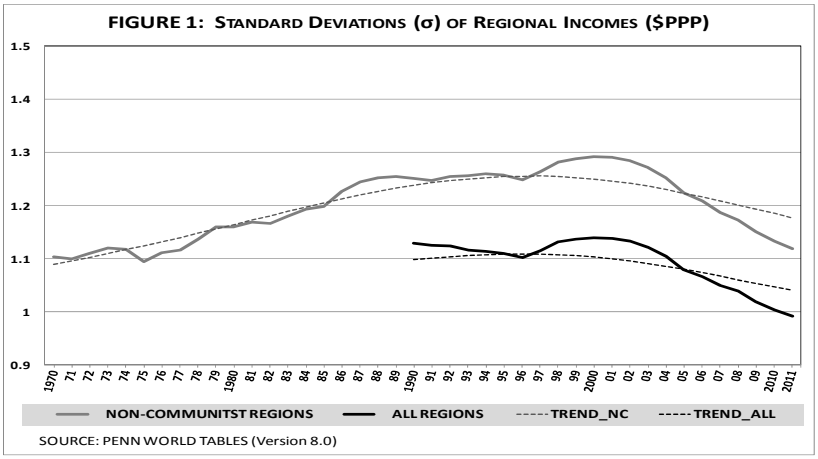
World Region	Trade (% GDP)			FDI (% GDP)			Portfolio Flows (% GDP)			High Tech. Exports (% Merchandise Trade)
	1980-89	1990-99	2000-11	1980-89	1990-99	2000-11	1980-89	1990-99	2000-11	2000-11
Central Asia	-	-	10.6	-	-	2.3	-	-	-0.5	-0.5
East Asia	3.3	1.5	20.2	0.1	0.7	0.5	0.0	0.2	0.2	0.2
Eastern Europe	-	-	0.0	-	-	1.8	-	-	0.8	3.4
Latin America	2.0	0.1	11.7	0.1	1.3	0.6	-0.1	2.1	-1.2	1.2
Middle East and North Africa	-10.8	-2.4	24.2	0.6	0.0	2.5	-0.2	0.1	0.2	0.3
North America	1.8	3.1	3.6	0.5	0.0	0.8	0.1	-0.1	0.1	-0.8
Pacific Regions	1.7	2.4	5.0	0.6	-0.6	2.0	1.6	0.0	4.3	0.0
South Asia	2.0	6.2	12.6	0.0	0.2	1.5	0.0	0.2	0.6	0.6
Sub-Saharan Africa	-0.2	4.9	12.9	-0.1	0.9	1.5	-0.1	1.7	-0.5	0.5
Western Europe	4.0	0.8	13.4	0.2	1.1	1.5	0.3	1.3	2.3	1.2
All Regions	0.5	2.1	11.4	0.3	0.4	1.5	0.2	0.7	0.6	0.6

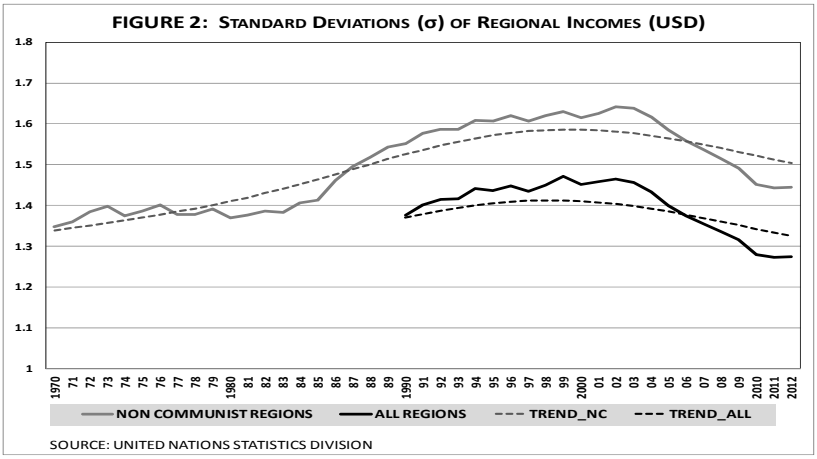
Data Sources: International Financial Statistics; UNCTAD; World Development Indicators.

3.4.1.2 Evidence of Broad (Sigma) Convergence/Divergence

If indeed, as the immediate evidence suggests, all regions experienced some degree of globalization (albeit to varying degrees) and, as some theories suggests, globalizing flows have convergence (or divergence) implications, we should observe broad patterns of convergence (or divergence) across world regions in the form of decreasing (or increasing) dispersion of regional outputs. Such broad convergence (across an unfiltered number of economic units) is referred to as sigma convergence. As the name suggests, convergence would be established by a declining standard deviation (sigma) of (log) per capita outputs across world regions. By contrast, an expanding standard deviation would suggest divergence.

Figures 1 and 2, below, indicate that, since 1970, world regions have experienced patterns of both convergence and divergence. That is true regardless of whether the measure of average per capita output used is in international (PPP) dollars or US dollars. From 1970 to 2000 (approximately) the dispersion of world output was generally expanding – indicating overall divergence. However, from 2000 to 2011 the standard deviation of regional outputs has been falling quite rapidly – indicating overall convergence in regional outputs. It is not clear what forces have been most important in generating these contrasting patterns. More specifically, determining whether globalization has affected this pattern at all will have to be left to further investigation since globalization has been occurring during both periods of convergence and divergence.



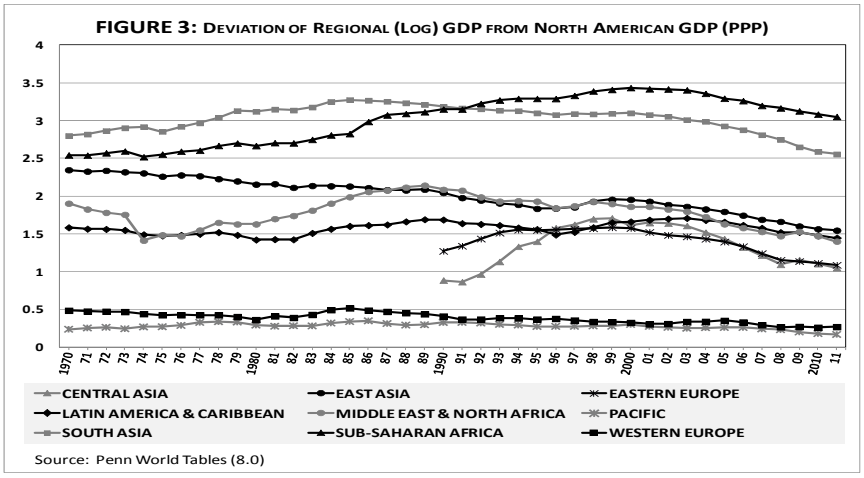


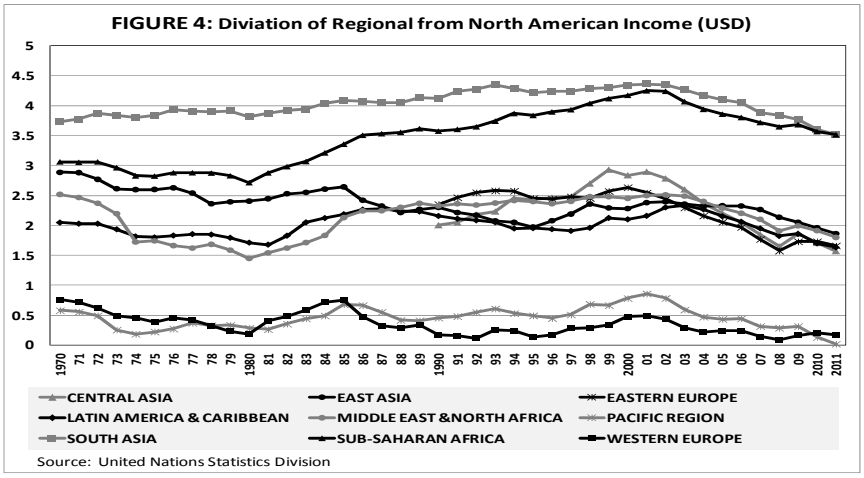
3.4.1.3 Pair-wise Comparisons: A Core-peripheral Analysis

Myrdal's definition of the "core" region(s) of the world economy as groupings of: "rich countries marked by the high "quality" and "effectiveness" of their factors of production" (Myrdal, 1957: 51) would seem to apply quite readily to the North American region (consisting of the economies of the United States and Canada). That region includes the world's largest economy and is constituted by two of the world's wealthiest and most productive economies. For further analysis, we therefore define the core regions of the world economy as the regional economy of North America. The remaining regions are treated as peripheral regions. Thus, "convergence (in output) to

the core" is here interpreted as convergence (in output) to the average output of North America.

It is clear from the presentation of output differentials in Figure 3 and Figure 4 (below) that, since 1970, there has been a wide range of movements in the outputs of peripheral regions relative to that of the core region. No region shows persistent and unequivocal convergence or divergence and the strength (and, sometimes the direction) of movement depends on whether outputs are compared using purchasing power parity (PPP) exchange rates or using US dollar exchange rates. East Asia comes closest to demonstrating persistent convergence but the downward trend (in output differentials) shows less persistence when output is measured in US dollars and, regardless of the choice of output measure, that trend is interrupted over the years of and immediately after the Asian crisis. The Sub-Saharan African region demonstrated unequivocal divergence in output from the core regions from (at least) 1980 to 2000 (across both output measures) but there has been a reversal in that trend from (roughly) 2000 to 2011. Both Eastern Europe and Central Asia experienced divergence in the period just after the demise of the Soviet Union but have experienced strong convergence since, at least, 2002. In fact, the most remarkable feature demonstrated by the graphic analyses is the near universal convergence or catch up in the outputs of all regions (to the core region's output) in the period 2000 to 2011 (excepting a small dip for some regions in 2008). Western Europe is the sole exception to that pattern as its income differential reflected the effect of the more lasting consequences of the global financial crisis for that region.





Tables A2.1 to A2.9 (Appendix) present the results of the pair-wise convergence tests for each region, relative to North America, and Table 3-2 (below) summarizes those results. The most immediate conclusion that can be drawn from the convergence tests is that no region indicates *stochastic convergence in output* to the core region (tests for μ=1 always reject the null). However, all regions demonstrated a *common trend in output* with the core ($0<\mu<1$). In fact, these results seem to make explicit what is implicit in the definitions of (stochastic) *convergence in output* and c*ommon trend in output* offered by Bernard and Durlauf (1995) – that convergence is merely a special case of a common trend and, likely, not a particularly common occurrence.

Table 3- 2: Results of Pair-wise Convergence Tests (with respect to North America)

Region Name	Measure of GDP Per Capita	Estimate of:		
		Common Trend (μ)	Catching-up (Det. Trend) (γ)	Drift (α)
Pacific Region	International Dollars	0.98	-	Negative (p)
	US Dollars	0.95	-	-
Western Europe	International Dollars	0.96	Positive (p)	Negative (p)
	US Dollars	0.94	Positive	-
Central Asia	International Dollars	0.90	Positive (p)	Negative (p)
	US Dollars	0.78	Negative (p)	Negative (p)
Eastern Europe	International Dollars	0.86	Positive (p)	
	US Dollars	0.80	Positive (p)	Negative (p)
Latin America and the Caribbean	International Dollars	0.84	Positive	-
	US Dollars	0.77	Positive	-
Middle East and North Africa	International Dollars	0.84	Mixed	-
	US Dollars	0.74	Positive	-
South Asia	International Dollars	0.70	Positive (p)	-
	US Dollars	0.79	Mixed	Negative
East Asia	International Dollars	0.76	Positive	-
	US Dollars	0.67	Positive	-
Sub-Saharan Africa	International Dollars	0.75	Negative (p)	Negative (p)
	US Dollars	0.66	Positive	Negative (p)

Notes: (p) – Indicates that the trend or drift term is relevant to only part of the sample period.

That being said, looking more closely at the results, it is clear that two regions (Western Europe and the Pacific Region) have common trends that approach unity and can therefore be considered very close to stochastic convergence (in output) with North America. The Pacific region is closest, with the suggestion that a small gap in per capita outputs will persist when outputs are measured in international dollars but the US dollar estimates suggest no such gap[46]. Western Europe has only slightly smaller common trend coefficients. For that region also, the international dollar output measures suggest a persistent gap in regional outputs up to 1991 (the period before the European Exchange Rate crisis) but that gap disappears for the period after the crisis.

[46] This is probably due to the fact that prices of nontraded goods are relatively high in pacific region (refer to OECD data on average annual wages).

One difference between the two regions is that, additionally for Western Europe, there is evidence of catching up (meaning a positive deterministic trend), particularly since 1992.

A second group of regions indicate large common trends but values that do not quite approach near convergence ($0.8<\mu<0.9$ when outputs are measured in international dollars and $0.7<\mu<0.8$ when outputs are measured in US dollars). Most of these regions also indicate catching up patterns with respect to the core region (Central Asia is one exception when income is measured in US dollars). A third group of regions indicate lower common trends ($\mu<0.8$ regardless of the measure of output). This pattern would seem to fit quite neatly into the Wallerstein (1974) description of a core group of regions (North America, The Pacific Region and Western Europe), an inner periphery of regions with relatively strong relationships to the core regions (Central Asia, Eastern Europe, Latin America & Caribbean, Middle East & North Africa), and a group of regions in the outer periphery with weaker (positive) economic relations with the core (East Asia, South Asia and Sub-Saharan Africa). This pattern also fits the income gradient quite well. The core regions are dominated by high-income countries, the inner periphery regions have average income in the middle-income range and the outer periphery regions have income in the low-income range.[47] The one outlier among these regions is East Asia, whose income average is at the middle-income level and shows clear evidence of catching-up with North America (Figures 3 and 4 and Table 2) but has low common trend values that are similar to those for the two low-income regions. We

[47] The terms "high-income," "middle-income" and "low-income" refer to the World Bank's criteria for ranking country incomes.

speculate that the low common trend values may reflect one of two (or both) influences particular to this region.

(1) As an advanced and highly influential economy in the region, Japan might weaken the influence of North America in the region through its effects on the patterns of growth in the region, particularly through foreign direct investment and involvement with regional supply chains in recent decades.

(2) As the largest and fastest growing economy in the region, China has a strong positive influence in the region's level of income and catching-up pattern. But it also has an influence on the common trend value and, given that the country is still engaged in the production of mostly low-technology goods – a structure that is more likely to fit an outer periphery country – it may be influencing that common trend valued downward.

3.4.1.4 Log t Tests of General and Club Convergence

We applied the log t convergence test to determine the presence of overall or club convergence across world regions during the post-Bretton Woods period (1970-2011)[48] for output denominated in both international dollars and US dollars.[49] The summarized test results are presented in Table 3-3. Regardless of the per capita income measure used, we do not find any indication of overall convergence among world regions. There is, however, evidence of two convergence clubs and several non-converging (and possibly diverging) units. For both measures of per capita income, Club 1 always includes Latin America and the Caribbean, Middle East and North Africa. Club

[48] For Central Asia and Eastern Europe only 1990 to 2011 is covered.
[49] Please refer to Appendix table A6.1 and Appendix table A6.2 for log t convergence test outputs.

2 always consists of North America and the Pacific Region. Sub-Saharan Africa is a part of Club 1 when output is measured in international dollars but not when output is measured in US dollars.[50] It is notable that the persistent members of Club 1 are middle-income (semi-periphery) countries while Club 2 is composed of the core regions of North America and the region with the strongest common trend (near convergence) with North America. Thus, there is significance correspondence between the log t test and the pair-wise convergence tests.

Table 3-3: Log t Test for Convergence Club(s) across World Regions

Club 1	Club 2	Non-converging Unit(s)
Per Capita Output in International dollars (PPP)		
Latin America and the Caribbean Middle East and North Africa Sub-Saharan Africa	North America Pacific Region	Central Asia East Asia Eastern Europe South Asia Western Europe
Per Capita Income in US Dollars		
Latin America and the Caribbean Middle East and North Africa	North America Pacific Region	Central Asia East Asia Eastern Europe South Asia Sub-Saharan Africa Western Europe

3.4.2 Globalizing Flows and the Output Differential

The estimation results are reported in Table 3-4 below. It is notable that, despite the differencing, the R-squared statistics are reasonable. Further the post estimation test results indicate that the model is not under-identified (Anderson canonical correlation LM Statistic) and the joint hypotheses that the instruments (second and

[50] It is likely that Central Asia and Eastern Europe are not found to belong to Club 1, as they naturally should as middle-income regions, because of the limited data for these two regions.

third lags of the dependent variable) are valid and correctly used purely as instruments is not rejected (the Sargan test).

Table 3-4: Determinants of the Output Differentials

RHS Variable (in logs)	Dependent Variable (in logs)	
	Δ Differential in $US Incomes	Δ Differential in PPP Incomes
Constant	-0.005	-0.002
	(-0.07)	(-0.45)
Lagged Dependent Variable	0.312*	0.719***
	(1.87)	(6.69)
Δ Trade/GDP Ratio	(0.24)	-0.166
	(0.24)	(-1.04)
Δ Foreign Direct Investment/GDP Ratio	0.550	0.099
	(1.26)	(0.47)
Δ Portfolio Investment Flows/GDP Ratio	0.264	-0.114
	(0.81)	(-0.75)
Δ High Technology Exports/GDP Ratio	0.545	0.015
	(0.48)	(0.03)
Δ Investment Rate Differential	-2.45***	-0.594***
(Regional average minus core average)	(-6.49)	(-3.04)
Δ Secondary School Enrollment Rate Differential	-0.097	0.117*
	(-0.74)	**(1.82)**
Δ Labour Force Growth Differential	0.948	0.165
	(1.34)	**(0.48)**
Δ Differential in Fuel and Manufacture Price Indices	-0.086**	-0.045***
	(-2.41)	(-2.64)
Δ Differential in Non-fuel and Manufacture Price Indices	-0.352***	-0.033
	-(4.34)	(-0.81)
R-Squared	0.52	0.50
Identification Test		
Anderson Canon Under-identification Test	20.869	54.444
	(0.000)	(0.000)
Sargan Over-identification Test for Validity of Instruments	1.120	0.444
	(0.290)	(0.505)
Number of Observations	162	162

Notes: *, ** and *** denote rejection of the null hypothesis at 10%, 5 % and 1% respectively.
Numbers in brackets are t-statistics (for identification tests, numbers in brackets are p-values)

For both measures of output, the coefficients of three variables consistently demonstrated strong statistical relationships with the dependent variable (the difference in per capita income between the peripheral regions and the core region of North America). These variables are: the lagged dependent variable (as expected); the (log) fuel commodity price differential (with respect to manufactured goods); and the (log) investment rate differential (between the peripheral region and the core). The latter two coefficients have negative signs – meaning that an increase in the variable value decreases the income differential, thus generating convergence. When incomes are measured in US dollars the (log) non-fuel commodity price differential (with respect to manufactured goods) is also significant (and negative) but it is not significant in the equation when incomes are measured in international dollars. This result suggests that the high non-fuel prices have a strong exchange rate effect in favour of peripheral regions but this does not translate into significant movements in domestic purchasing power – perhaps an indication of some Dutch Disease-related consequences. The differential in secondary school enrollment (between the peripheral and core regions) was significant when incomes were measured in international dollars, but with a positive sign. This is likely because the best performing regions (in terms of closing the secondary education gap with the core) were the rich pacific region and the middle-income Latin America and the Caribbean and East Asia regions rather than the poorest regions such as South Asia and Sub-Saharan Africa. We do not take this to imply (necessarily) that human capital formation is not conducive to growth in the periphery but, instead, that (gross) secondary school enrolment is not a particularly good proxy for that experience.[51]

[51] General or youth literacy rates would have been another option but this data is not available on a yearly

Of perhaps greatest relevance to this investigation is the performance of globalizing variables. None of these variables were significant regardless of the measure of per capita income differentials used. To a certain degree, this is not surprising because the sigma convergence test had suggested that, when all regions are considered, both catch-up and divergence had occurred during this period of rapid globalization (1990 to 2011). Given that the 1990s was generally a period of divergence and the 2000s a period of catch up it would seem unlikely that a phenomenon that was common to both periods could explain (or be explained by) both opposite movements. However, we cannot conclude that these globalizing flows do not have convergence or divergence effects even at country levels. What can be said is that the country level effects of these variables are not likely generalized within a region. In short, any generalized (meaning universal) convergence impulses (including catch-up) are more likely explained by other phenomena.

In terms of forces generating convergence impulses, the estimation results offer two clear candidates – investment rates in the periphery and relative increases in fuel prices. The implication that higher rates of investment in the peripheral regions generate convergence is not particularly surprising. Most growth models (neoclassical, new growth and structuralist models) would be compatible with that result – though they might disagree about what the content of that investment would need to be to elicit that result.[52] The more surprising result is the importance of fuel prices (relative to the price of manufactured goods). This clearly suggests that the price behaviour of a class of

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basis for many countries.

[52] The arguments would likely center on division between foreign-investment proportion (and nature) and the accompanying human capital.

primary exports has strong convergence (or divergence) implications. Beyond the fact that this result can be seen as a partial confirmation of the structuralist position (that relative commodity prices matter) it also suggests that one of the presumptions of the core-periphery model itself – that the periphery's growth is largely dependent on the core's need for primary products still has more than a grain of truth, even in the context of industrialized emerging market economies in the periphery.

3.5 CONCLUSION

If we accept the International Monetary Fund Definition of Globalization as: "The increasing integration of economies around the world, particularly through trade and financial flows…[and] the movement of people (labor) and knowledge (technology) across international borders," the fact of globalization is not particularly contentious. However, the consequence implications of globalization at the level of world regions have not been investigated in any generalized way and are thus not well understood. The investigation presented here began by disaggregating the world into ten world regions – with one of them (North America) defined as a core region and the remaining regions defined as peripheral regions. An initial analysis of output dispersion across world regions (sigma convergence tests) revealed that, in general, the level of dispersion was rising from (at least) 1980 to 2000. However, the first decade of the 21st century has seen a rapid decline in the dispersion of regional outputs that was interrupted, but not halted, by the global financial crisis.

In terms of the performance of individual peripheral regions relative to the core, on the positive side, there is no visual evidence that any region has persistently diverged from the core region (in terms of per capita output) since the 1970s but there

is also no evidence of uninterrupted catching-up on the part of any peripheral region. Sub Saharan Africa experienced the longest period of divergence (through the 1980s and 1990s) but it also experienced a strong catching-up pattern after 2000. East Asia experienced a strong catching-up pattern through the 1970s and 1980s but that was interrupted by the Asian financial crisis, though it has since resumed. Central Asia and Eastern Europe, not surprisingly, demonstrated strong divergence from the core in the 1990s (after the demise of the Soviet Union) but have demonstrated equally strong catching-up since then.

More formally, tests of pair-wise convergence between the core and peripheral regions indicate that no region demonstrated stochastic *convergence in output* to the core region (according to the Bernard and Durlauf (1995) definition). However, all regions demonstrated a *common trend in output* with the core. As well, the strength of that common trend varied significantly across peripheral regions. The Pacific Region (Australia, Fiji, New Zealand and Papua New Guinea) and Western Europe had common trends that were near unity – indicating near convergence with the core. Four middle-income regions (Central Asia, Eastern Europe, Latin America & Caribbean and Middle East & North Africa) had large but smaller common trend coefficients – suggesting semi-periphery status. Three regions (East Asia, South Asia and Sub-Saharan Africa) had small common trend coefficients that suggest outer periphery status. East Asia's low common trend with North America remains the only anomalous result.

A test of overall and club convergence (the log t test) indicate that there was no evidence of overall convergence among all world regions. However, across the two measures of output (international dollars and US dollars) two convergence clubs could be identified. The first club always included Latin America & Caribbean and the Middle

East and North Africa and the members of the second club were North America and the Pacific Region (dominated by Australia and New Zealand). The first club is clearly a club of semi-periphery, middle-income regions and the second is clearly a club of core, high-income, regions. Surprisingly, when income is measured in international (PPP) dollars it is Sub-Saharan Africa, and not East Asia, Eastern Europe or Central Asia, that joins the middle-income region club. It is also surprising that Western Europe is not part of the high-income club.[53]

At a theoretical level, the flows of trade, finance and technology that are thought to be responsible for globalization are also thought to be closely associated with convergence or divergence in country (and, therefore, regional) outputs. We therefore sought to determine whether these flows could be shown to be directly related to changes in core-periphery output gaps. Using panel data regression analysis, we found that none of the globalizing variables (trade, finance or technology flows) had any strong statistical association with changes in regional output differentials (regardless of the measure of output used). The most powerful influences on regional output differentials, and therefore on convergence (or catch-up) or divergence, were the investment gap (the difference between the core and periphery investment rates) and the differential between the price of fuels (essentially oil and gas) and the price of manufactured goods. Higher investment in the periphery and higher (relative) fuel prices appear to generate convergence impulses while the opposite generate divergence impulses. Moreover, the importance of fuel prices lends support to a core presumption

[53] We suspect that this is because Sub-Saharan Africa's catch-up in the 2000s is particularly strong and Western Europe has a slightly weaker catch-up experience than the Pacific region in the same period.

of the core-periphery framework – that primary commodity exports to the core play a large part in determining the rate of growth of peripheral economies.

Appendix

Table A1: World Regions

1.Central Asia	2.East Asia	3.Eastern Europe	4.Latin America and the Caribbean	5.Middle East and North Africa	6.North America	9.Sub-Saharan Africa		10.Western Europe
Armenia	Brunei	Albania	Argentina	Algeria	Canada	Angola	Madagascar	Austria
Azerbaijan	Cambodia	Belarus	Bahamas, The	Bahrain	United States	Benin	Malawi	Belgium
Georgia	China	Bosnia and Herzegovina	Barbados	Egypt, Arab Rep.	**7.Pacific Countries**	Botswana	Mali	Cyprus
Kazakhstan	Indonesia	Bulgaria	Bolivia	Iran, Islamic Rep.	Australia	Burkina Faso	Mauritania	Denmark
Kyrgyz Republic	Japan	Croatia	Brazil	Iraq	Fiji	Burundi	Mauritius	Finland
Russian Federation	Korea, Rep.	Czech Republic	Chile	Israel	New Zealand	Cameroon	Mozambique	France
Tajikistan	Lao PDR	Estonia	Colombia	Jordan	Papua New Guinea	Central African Republic	Namibia	Germany
Turkey	Malaysia	Hungary	Costa Rica	Kuwait	**8.South Asia**	Chad	Niger	Greece
Turkmenistan	Mongolia	Kosovo	Cuba	Lebanon	Bangladesh	Comoros	Nigeria	Iceland
Uzbekistan	Myanmar	Latvia	Dominican Republic	Libya	Bhutan	Congo, Dem. Rep.	Rwanda	Ireland
	Philippines	Lithuania	Ecuador	Malta	India	Congo, Rep.	Senegal	Italy
	Singapore	Macedonia, FYR	El Salvador	Morocco	Maldives	Cote d'Ivoire	Seychelles	Luxembourg
	Thailand	Moldova	Guatemala	Oman	Nepal	Equatorial Guinea	Sierra Leone	Netherlands
	Vietnam	Montenegro	Guyana	Qatar	Pakistan	Ethiopia	South Africa	Norway
		Poland	Haiti	Saudi Arabia	Sri Lanka	Gabon	Sudan	Portugal
		Romania	Honduras	Syrian Arab Republic		Gambia, The	Swaziland	Spain
		Serbia	Jamaica	Tunisia		Ghana	Tanzania	Sweden
		Slovak Republic	Mexico	United Arab Emirates		Guinea	Togo	Switzerland
		Slovenia	Nicaragua	Yemen, Rep.		Guinea-Bissau	Uganda	United Kingdom
		Ukraine	Panama			Kenya	Zambia	
			Paraguay			Lesotho	Zimbabwe	
			Peru			Liberia		
			Puerto Rico					
			Suriname					
			Trinidad and Tobago					
			Uruguay					
			Venezuela, RB					

Table A2.1: Pair-wise Convergence Tests – Central Asia

Stationarity Test for the Output Differential (USD)						
Dependent Variable	Coefficient	T-Statistic	P-Value	CLEMAO1 (du1) CLEMAO1 (du2)	CLEMAO1 (ρ-1)	Decision
Output Differential between North America and Central Asia				4.099*** -7.974***	-3.272 (-5.490**)	Stationary with breaks in 1995 and 2004
Fully Modified Ordinary Leas Squares (FMOLS) – Dependent Variable: Log of GDP for Central Asia						
Right-Hand-Side Variables	Coefficient	T-Statistic	P-Value	KPSS Test	DF-GLS Test	Decision
Constant (1995-2003)	-0.393	-7.77***	0.000			
Trend (2004-2011)	-0.100	10.23***	0.000			
Log GDP of North America	0.780	203.98***	0.000			
Residual				0.150	-2.761***	Residual is I(0) (Cointegration)
Test for Unit Coefficient ([1-1] Cointegrating relationship)						
Chi-Square Statistic	3301.28		0.000***			Coefficient ≠ 1
Stationarity Test for the Output Differential (PPP)						
Dependent Variable	Coefficient	T-Statistic	P-Value	CLEMAO1 (du1) CLEMAO1 (du2))	CLEMIO1 (ρ-1)	Decision
Output Differential between North America and Central Asia				.7.067*** -6.244***	-2.679 (-5.490**)	Stationary with a breaks in 1995 and 2005
Fully Modified Ordinary Leas Squares (FMOLS) – Dependent Variable: Log of GDP for Central Asia						
Right-Hand-Side Variables	Coefficient	T-Statistic	P-Value	KPSS Test	DF-GLS Test	Decision
Constant (1995-2011)	-0.513	-10.79***	0.000			
Trend (2005-2011)	0.086	10.31***	0.000			
Log GDP of North America	0.899	231.04***	0.000			
Residual				0.118	-2.669***	Residual is I(0) (Cointegration)
Test for Unit Coefficient ([1-1] Cointegrating Equation)						
Chi-Square Statistic	670.35		0.000			Coefficient ≠ 1

Source: Author's Calculations Using UN and PWT data

Table A2.2: Pair-wise Convergence Tests – East Asia

Stationarity Test for the Output Differential (USD)						
Dependent Variable				CLEMAO1 (du1)	CLEMAO1 (ρ-1)	Decision
Log Income Differential between North America and East Asia				-6.427	-3.413 (-3.560**)	Stationary with a break in 1989
Fully Modified Ordinary Leas Squares (FMOLS) – Dependent Variable: Log of GDP for East Asia						
Right-Hand-Side Variables	Coefficient	T-Statistic	P-Value	KPSS Test	DF-GLS Test	Decision
Trend	0.052	13.00***	0.000			
Trend (1989-2011)	-0.033	-5.86***	0.000			
Log GDP – North America	0.671	115.02***	0.000			
Residual				0.072	-3.644***	Residual is I(0) (Cointegration)
Test for Unit Coefficient ([1-1] Cointegrating Equation)						
Chi-Square Statistic	3172.69		0.000***			Coefficient ≠ 1
Stationarity Test for the Output Differential (PPP)						
Dependent Variable				KPSS Test	DF-GLS Test	Decision
Log Income Differential between North America and East Asia				0.088	-3.239**	Trend Stationary
Fully Modified Ordinary Leas Squares (FMOLS) – Dependent Variable: Log of GDP for East Asia						
Right-Hand-Side Variables	Coefficient	T-Statistic	P-Value	KPSS Test	DF-GLS Test	Decision
Trend	0.022	35.81***	0.000			
Log GDP – North America	0.760	510.42***	0.000			
Residual				0.080	-3.351***	Residual is I(0) (Cointegration)
Test for Unit Coefficient ([1-1] Cointegrating Equation)						
Chi-Square Statistic	25927		0.000			Coefficient ≠ 1

Source: Author's Calculations Using UN and PWT data

Table A2.3: Pair-wise Convergence Tests – Eastern Europe

Stationarity Test for the Output Differential (USD)						
Dependent Variable				CLEMIO1 (du1)	CLEMIO1 (ρ-1)	Decision
Output Differential between North America and Eastern Europe				-10.702***	-3.536 (-3.560**)	Stationary with a break in 2009
Fully Modified Ordinary Leas Squares (FMOLS) – Dependent Variable: Log of GDP for Eastern Europe						
Right-Hand-Side Variables	Coefficient	T-Statistic	P-Value	KPSS Test	DF-GLS Test	
Constant (1990-2003)	- 0.428	- 8.28***	0.000			
Trend (2004-2011)	0.071	7.14***	0.000			
Log GDP of North America	0.799	169.62***	0.000			
Residual				0.094	-4.172***	Residual is I(0) (Cointegration)
Test for Unit Coefficient ([1-1] Cointegrating Equation)						
Chi-Square Statistic	1824.31		0.000***			Coefficient ≠ 1
Stationarity Test for the Output Differential (PPP)						
Dependent Variable				CLEMIO1 (du1)	CLEMIO1 (ρ-1)	Decision
Output Differential between North America and Eastern Europe				-3.220***	-3.457 (-4.270**)	Stationary with a break in 2004
Fully Modified Ordinary Leas Squares (FMOLS) – Dependent Variable: Log of GDP for Eastern Europe						
Right-Hand-Side Variables	Coefficient	T-Statistic	P-Value	KPSS Test	DF-GLS Test	Decision
Trend (2004-2011)	0.059	11.03***	0.000			
Log GDP – North America	0.857	542.81***	0.000			
Residual				0.141	-2.060**	Residual is I(0) (Cointegration)
Test for Unit Coefficient ([1-1] Cointegrating Equation)						
Chi-Square Statistic	8209.39		0.000			Coefficient ≠ 1

Source: Author's Calculations Using UN and PWT data

Table A2.4: Pair-wise Convergence Tests – Latin America and the Caribbean

Stationarity Test for the Output Differential (USD)						
Dependent Variable	Coefficient	T-Statistic	P-Value	KPSS Test	DF-GLS Test	Decision
Log Income Differential between North America and Latin America & the Caribbean				0.173	-2.103***	Level Stationary
Fully Modified Ordinary Leas Squares (FMOLS) - Dependent Variable: Log of GDP for Latin America and the Caribbean						
Right-Hand-Side Variables	Coefficient	T-Statistic	P-Value	KPSS Test	DF-GLS Test	Decision
Trend	0.119	4.26***	0.000			
Log GDP – North America	0.773	110.54***	0.000			
Residual				0.160	-3.093***	Residual is I(0) (Cointegration)
Test for Unit Coefficient ([1-1] Cointegrating Equation)						
Chi-Square Statistic	1049.63***		0.000			Coefficient ≠ 1
Stationarity Test for the Output Differential (PPP)						
Dependent Variable	Coefficient	T-Statistic	P-Value	CLEMAO1 (du1)	CLEMAO1 (ρ-1)	Decision
Log Income Differential between North America and Latin America and the Caribbean				4.108***	-3.099 (-3.560**)	Stationary with a Structural Break in 1986
Fully Modified Ordinary Least Squares (FMOLS) - Dependent Variable: Log of GDP for Latin America and the Caribbean						
Right-Hand-Side Variables	Coefficient	T-Statistic	P-Value	KPSS Test	DF-GLS Test	Decision
Trend (1970-1985)	0.011	3.15***	0.002			
Trend (1986-2011)	0.005	2.56***	0.010			
Log GDP – North America	0.841	283.18***	0.000			
Residual				0.097	-2.918***	Residual is I(0) (Cointegration)
Test for Unit Coefficient ([1-1] Cointegrating Equation)						
Chi-Square Statistic	2868.26***		0.000			Coefficient ≠ 1

Source: Author's Calculations Using UN and PWT data

Table A2.5: Pair-wise Convergence Tests – Middle East and North Africa (MENA)

Stationarity Test for the Output Differential (USD)						
Dependent Variable	Coefficient	T-Statistic	P-Value	CLEMAO1 (du1)	CLEMAO1 (ρ-1)	Decision
Output Differential between North America and MENA				4.792***	-2.067 (-3.560**)	Stationary with a break in 1986
Fully Modified Ordinary Leas Squares (FMOLS) – Dependent Variable: Log of GDP for Middle East and North Africa						
Right-Hand-Side Variables	Coefficient	T-Statistic	P-Value	KPSS Test	DF-GLS Test	Decision
Trend (1970-85)	0.065	5.45***	0.000			
Trend (1986-2011)	0.030	4.11***	0.000			
Log GDP – North America	0.740	69.30***	0.000			
Residual				0.111	-2.203**	Residual is I(0) (Cointegration)
Test for Unit Coefficient ([1-1] Cointegrating Equation)						
Chi-Square Statistic	596.91		0.000***			Coefficient ≠ 1
Stationarity Test for the Output Differential (PPP)						
Dependent Variable	Coefficient	T-Statistic	P-Value	CLEMAO1 (du1)	CLEMAO1 (ρ-1)	Decision
Output Differential between North America and MENA				-2.529**	-0.807 (-4.270**)	Level Stationary with a break in 2009
Fully Modified Ordinary Leas Squares (FMOLS) – Dependent Variable: Log of GDP for the Middle East and North Africa						
Right-Hand-Side Variables	Coefficient	T-Statistic	P-Value	KPSS Test	DF-GLS Test	Decision
Trend	-0.013	-5.76***	0.000			
Trend (2009-2011)	0.156	4.76***	0.000			
Log GDP – North America	0.842	248.35***	0.000			
Residual				0.206	-2.442**	Residual is I(0) (Cointegration)
Test for Unit Coefficient ([1-1] Cointegrating Equation)						
Chi-Square Statistic	1072		0.000			Coefficient ≠ 1

Source: Author's Calculations Using UN and PWT data

Table A2.6: Pair-wise Convergence Tests – Pacific Region

Stationarity Test for the Output Differential (USD)						
Dependent Variable	Coefficient	T-Statistic	P-Value	KPSS Test	DF-GLS Test	Decision
Output Differential between North America and the Pacific Region				0.234	-3.326***	Level Stationary
Fully Modified Ordinary Least Squares (FMOLS) – Dependent Variable: Log of GDP for the Pacific Region						
Right-Hand-Side Variables	Coefficient	T-Statistic	P-Value	KPSS Test	DF-GLS Test	Decision
Log GDP – North America	0.954	188.23***	0.000			
Residual				0.176	-3.219***	Residual is I(0) (Cointegration)
Test for Unit Coefficient ([1-1] Cointegrating Equation)						
Chi-Square Statistic	80.66		0.000***			Coefficient ≠ 1
Stationarity Test for the Output Differential (PPP)						
Dependent Variable	Coefficient	T-Statistic	P-Value	CLEMAO1 (du1)	CLEMAO1 (ρ-1)	Decision
Output Differential between North America and the Pacific Region				-5.518***	-3.442 (-3.560**)	Stationary with a Structural Break in 2004
Fully Modified Ordinary Least Squares (FMOLS) – Dependent Variable: Log of GDP for Pacific Region						
Right-Hand-Side Variables	Coefficient	T-Statistic	P-Value	KPSS Test	DF-GLS Test	Decision
Constant (1970-2003)	-0.080	-6.37***	0.000			
Log GDP – North America	0.980	898.89***	0.000			
Residual				0.139	-2.356***	Residual is I(0) (Cointegration)
Test for Unit Coefficient ([1-1] Cointegrating Equation)						
Chi-Square Statistic	35.31		0.000			Coefficient ≠ 1

Source: Author's Calculations Using UN and PWT data

Table A2.7: Pair-wise Convergence Tests – South Asia

Stationarity Test for the Output Differential (USD)						
Dependent Variable	Coefficient	T-Statistic	P-Value	CLEMIO1 (du1)	CLEMIO1 (ρ-1)	Decision
Output Differential between North America and South Asia				-2.409**	-1.271 (-4.270**)	Stationary with a break in 2005
Fully Modified Ordinary Least Squares (FMOLS) – Dependent Variable: Log of GDP for South Asia						
Right-Hand-Side Variables	Coefficient	T-Statistic	P-Value	KPSS Test	DF-GLS Test	Decision
Constant	-1.936	-5.29***	0.000			
Trend (1970-2004)	-0.006	-2.50**	0.013			
Trend (2005-2011)	0.094	5.44***	0.000			
Log GDP – North America	0.791	19.55***	0.000			
Residual				0.095	-3.714***	Residual is I(0) (Cointegration)
Test for Unit Coefficient ([1-1] Cointegrating Equation)						
Chi-Square Statistic	26.71		0.000***			Coefficient ≠ 1
Stationarity Test for the Output Differential (PPP)						
Dependent Variable	Coefficient	T-Statistic	P-Value	CLEMIO1 (du1)	CLEMIO1 (ρ-1)	Decision
Output Differential between North America and South Asia				-3.391***	-2.305 (-4.270**)	Stationary with a break in 2003
Fully Modified Ordinary Least Squares (FMOLS) – Dependent Variable: Log of GDP for South Asia						
Right-Hand-Side Variables	Coefficient	T-Statistic	P-Value	KPSS Test	DF-GLS Test	Decision
Trend (2003-11)	0.074	4.99***	0.000			
Log GDP – North America	0.700	185.95***	0.000			
Residual				0.287	-2.238**	Residual is I(0) (Cointegration)
Test for Unit Coefficient ([1-1] Cointegrating Equation)						
Chi-Square Statistic	6378.99		0.000			Coefficient ≠ 1

Source: Author's Calculations Using UN and PWT data

Table A2.8: Pair-wise Convergence Tests –Sub-Saharan Africa

Stationarity Test for the Output Differential (USD)						
Dependent Variable	Coefficient	T-Statistic	P-Value	CLEMAO1 (du1)	CLEMAO1 (ρ-1)	Decision
Output Differential between North America and Sub-Saharan Africa				11.120***	-2.916 (-3.560**)	Stationary with a break in 1987
Fully Modified Ordinary Least Squares (FMOLS) – Dependent Variable: Log of GDP for Sub-Saharan Africa						
Right-Hand-Side Variables	Coefficient	T-Statistic	P-Value	KPSS Test	DF-GLS Test	Decision
Constant (1987-2011)	-0.673	-4.67***	0.000			
Trend	0.012	2.02**	0.043			
Log GDP of North America	0.663	70.52***	0.000			
Residual				0.156	-2.098**	Residual is I(0) (Cointegration)
Test for Unit Coefficient ([1-1] Cointegrating Equation)						
Chi-Square Statistic	1285		0.000***			Coefficient ≠ 1
Stationarity Test for the Output Differential (PPP)						
Dependent Variable	Coefficient	T-Statistic	P-Value	CLEMIO1 (du1)	CLEMIO1 (ρ-1)	Decision
Output Differential between North America and Sub-Saharan Africa				12.190***	-2.085 (-3.560**)	Stationary with a break in 1988
Fully Modified Ordinary Least Squares (FMOLS) – Dependent Variable: Log of GDP for Sub-Saharan Africa						
Right-Hand-Side Variables	Coefficient	T-Statistic	P-Value	KPSS Test	DF-GLS Test	Decision
Constant (1988-2011)	-0.683	-16.17***	0.000			
Trend (1970-1987)	**-0.022**	**-6.52***	**0.000**			
Log GDP – North America	0.756	199.33***	0.000			
Residual				0.162	-2.509**	Residual is I(0) (Cointegration)
Test for Unit Coefficient ([1-1] Cointegrating Equation)						
Chi-Square Statistic	4149.14		0.000			Coefficient ≠ 1

Source: Author's Calculations Using UN and PWT data

Table A2.9: Pair-wise Convergence Tests – Western Europe

Stationarity Test for the Output Differential (USD)						
Dependent Variable	Coefficient	T-Statistic	P-Value	KPSS Test	DF-GLS Test	Decision
Output Differential between North America and Western Europe				0.070	-3.296**	Level Stationary
Fully Modified Ordinary Least Squares (FMOLS) – Dependent Variable: Log of GDP for Western Europe						
Right-Hand-Side Variables	Coefficient	T-Statistic	P-Value	KPSS Test	DF-GLS Test	Decision
Trend	0.012	7.34***	0.000			
Log GDP – North America	0.940	239.13***	0.000			
Residual				0.082	-2.575**	Residual is I(0) (Cointegration)
Test for Unit Coefficient ([1-1] Cointegrating Equation)						
Chi-Square Statistic	232.83		0.000***			Coefficient ≠ 1
Stationarity Test for the Output Differential (PPP)						
Dependent Variable	Coefficient	T-Statistic	P-Value	CLEMAO1 (du1)	CLEMAO1 (ρ-1)	Decision
Output Differential between North America and Western Europe				-8.587***	-2.560 (-3.560**)	Stationary with a Structural Break in 1992
Fully Modified Ordinary Least Squares (FMOLS) – Dependent Variable: Log of GDP for Western Europe						
Right-Hand-Side Variables	Coefficient	T-Statistic	P-Value	KPSS Test	DF-GLS Test	Decision
Constant (1970-91)	-0.053	-4.75***	0.000			
Trend (1992-2011)	0.007	7.86***	0.000			
Log GDP – North America	0.962	976.05***	0.000			
Residual				0.087	-2.383**	Residual is I(0) (Cointegration)
Test for Unit Coefficient ([1-1] Cointegrating Equation)						
Chi-Square Statistic	1475.59***		0.000			Coefficient ≠ 1

Source: Author's Calculations Using UN and PWT data

Table A3.1: Unit Root Tests of Potential Explanatory Variables

Variable Name	Unit Root Tests Null of Unit Root(s)		
Inter-regional Flows	**Levin-Lin-Chu**	**Im-Pesaran-Shin**	**Decision**
Trade/GDP Ratio	-3.0579***	-0.4786*	Level Stationary I(0)
Foreign Direct Investment/GDP Ratio	-4.2610***	-3.5011***	Level Stationary I(0)
Portfolio Investment Flows/GDP Ratio	-5.1637***	-5.1590***	Level Stationary I(0)
High Technology Exports/GDP Ratio	-4.5056***	-3.6431***	Level Stationary I(0)
Investment Rate Differential	-3.0063***	-2.5343***	Level Stationary I(0)
Labour Force Growth Differential	-2.8839***	-3.9180***	Level Stationary I(0)
Secondary School Enrollment Differential	-2.2906***	-3.6795***	Level Stationary I(0)
Commodity Price Indices	**DFGLS** Null of Unit Root(s)	**KPSS** Null of Level Stationary	**Decision**
Differential in Global Commodities and Manufactured Goods Indices	0.553	0.772**	Non-Stationary I(1)
Differential in Fuel Commodities and Manufactured Goods Indices	-6.906***	0.789**	Level Stationary I(0)
Differential in the Non-Fuel Commodities and Manufactured Goods Indices	-1.915**	0.621*	Level Stationary I(0)

* Rejected at the 10% level
** Rejected at the 5% level
*** Rejected at the 1% level

Table A3.2: Unit Root Test of (Log) Regional Incomes (in US Dollars)

Region	Test Statistic (Levels)		Test Statistic (First Difference)		Level of Integration
	KPSS	DFGLS	KPSS	DFGLS	
Central Asia[(a)]	0.224***	-1.501	0.103	-3.999***	I(1)
East Asia	0.317***	-1.880	0.305	-3.316***	I(1)
Eastern Europe[(b)]	0.173**	-1.665	0.209	-2.913***	I(1)
Latin America & Caribbean	0.106	-2.526	0.122	-3.775***	I(1)
Middle East & North Africa	0.174**	-1.681	0.296	-3.017***	I(1)
North America	0.394***	-0.964	0.079	-4.480***	I(1)
Pacific Region	0.153**	-1.820	0.140	-3.982***	I(1)
South Asia	0210**	-1.479	0.199	-3.072***	I(1)
Sub-Saharan Africa	0.189**	-1.720	0.206	-3.135***	I(1)
Western Europe	0.261***	-1.641	0.050	-4.265***	I(1)

Data source: Penn World Tables (8.0). *, ** & *** denote rejection of the null hypothesis at 10%, 5 % and 1% levels respectively;

(a) Covers the period 1992 to 2011; (b) Covers the period 1990 to 2010;

Table A3.3: Unit Root Test of (Log) Regional Incomes (in International Dollars)

Region	Test Statistic (Levels)		Test Statistic (First Difference)		Level of Integration
	KPSS	DFGLS	KPSS	DFGLS	
Central Asia[(a)]	0.168**	-1.210	0.107	-3.593**	I(1)
East Asia	0.065	-3.292**	0.040	-4.707***	Trend, I(0)
Eastern Europe[(b)]	0.172**	-2.168	0.321	-2.948**	I(1)
Latin America & Caribbean	0.123*	-2.369	0.099	-4.365***	I(1)
Middle East & North Africa	0.317**	-2.050	0.201	-2.719***	I(1)
North America	0.118	-2.723	0.063	-4.728***	I(1)
Pacific Region	0.206**	-1.803	0.053	-5.975***	I(1)
South Asia	0.396***	-2.375	0.071	-4.837***	I(1)
Sub-Saharan Africa	0.324***	-2.754	0.238***	-4.357***	I(1)
Western Europe	0.107	-2.797	0.077	-3.508***	I(1)

Data source: Penn World Tables (8.0). *, ** & *** denote rejection of the null hypothesis at 10%, 5 % and 1% levels respectively;

(a) Covers the period 1992 to 2011; (b) Covers the period 1990 to 2010;

Table A4.1: Coefficients: IV (2SLS) Regression (Dependent Variable measured in US)

Number of Observation=162
F(10, 151)=11.79
Prob>F=0.0000
Centered R2=0.04800
Uncentered R2=0.5203
Root MSE=0.06918

RHS Var.	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
D.diffyus						
LD.	0.312366	0.172757	1.81	0.071	-0.02623	0.650963
ltradey						
D1.	0.09061	0.3916	0.23	0.817	-0.67691	0.858133
lfdiy						
D1.	0.550166	0.451325	1.22	0.223	-0.33441	1.434746
lporty						
D1.	0.263659	0.33666	0.78	0.434	-0.39618	0.923501
lhtecy						
D1.	0.544953	1.169641	0.47	0.641	-1.7475	2.837408
dlnoil						
D1.	-0.85841	0.03695	-2.32	0.020	-0.15826	-0.01342
dlnnfuel						
D1.	-0.35237	0.084119	-4.19	0.000	-0.51724	-0.1875
difflinvy						
D1.	-2.45164	0.391423	-6.26	0.000	-3.21881	-1.68447
dlsschool						
D1.	-0.09691	0.136058	-0.71	0.476	-0.36358	0.169759
dlglabor						
D1.	0.947787	0.730873	1.30	0.195	-0.4847	2.380271
_cons	-0.00055	0.008697	-0.06	0.950	-0.01759	0.016497

Identification test	P -Value
Anderson Canon under-identification test	0.0000
Sargan test	0.2900

Table A4.2: Coefficients: IV (2SLS) Regression (Dependent Variable measured in PPP)

Number of Observation=162
F(10, 151)=11.98
Prob>F=0.0000
Centered R2=0.4320
Uncentered R2=0.4983
Root MSE=0.03346

RHS Var.	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
D.diffyppp						
LD.	0.7185	0.1074482	6.69	0	0.507916	0.929106
ltradey						
D1.	-0.1660	0.1596446	-1.04	0.298	-0.47892	0.146879
lfdiy						
D1.	0.0986	0.2098482	0.47	0.638	-0.31264	0.509951
lporty						
D1.	-0.1141	0.1517778	-0.75	0.452	-0.41163	0.183328
lhtecy						
D1.	0.0154	0.5164742	0.03	0.976	-0.99684	1.027702
dlnoil						
D1.	-0.0448	0.0169823	-2.64	0.008	-0.07811	-0.01154
dlnnfuel						
D1.	-0.0327	0.0403826	-0.81	0.418	-0.11186	0.046433
difflinvy						
D1.	-0.5933	0.1951296	-3.04	0.002	-0.97574	-0.21085
dlsschool						
D1.	0.1175	0.064415	1.82	0.068	-0.00876	0.243741
dlglabor						
D1.	0.1647	0.342368	0.48	0.63	-0.50631	0.835747
_cons	-0.0016	0.003657	-0.45	0.654	0.654	-0.00881

Identification test	P -Value
Anderson Canon under-identification test	0.0000
Sargan test	0.5051

Table A5: Variable List and Data Source

Potential Dependent and Independent Variables	Data Source
Coefficient of variation of intra-regional per capita GDP distribution (GDP measured in US dollars)	United Nation Statistic Division, UN data 2014
Coefficient of variation of intra-regional per capita GDP distribution (GDP measured in international dollars)	Penn World Table 7.0, University of Pennsylvania
Gross fixed capital formation (% GDP)_High income	World Development Indicator, World Bank
Gross fixed capital formation (% GDP)_Low income	World Development Indicator, World Bank
Secondary school enrollment rate _High income	World Development Indicator, World Bank
Secondary school enrollment rate _Low income	World Development Indicator, World Bank
Growth rate of working age population _High income	World Development Indicator, World Bank
Growth rate of working age population _Low income	World Development Indicator, World Bank
World export % gdp	UN Comtrade Database
Inter-regional export % gdp	UN Comtrade Database
World import % gdp	UN Comtrade Database
Inter-regional import % gdp	UN Comtrade Database
Intra-regional trade % gdp	UN Comtrade Database
World FDI inflow % gdp	OECD Stat
Inter-regional FDI inflow % gdp	OECD Stat
Intra-regional FDI inflow % gdp	OECD Stat
World portfolio inflow % gdp	OECD Stat
Inter–regional portfolio inflow % gdp	OECD Stat
Intra–regional portfolio inflow % gdp	OECD Stat
World import hi_tech % all commodities	UN Comtrade Database
Inter-regional import hi_tech % all commodities	UN Comtrade Database
World export hi_tech % all commodities	UN Comtrade Database
Inter-regional export hi_tech % all commodities	UN Comtrade Database
World trade hi_tech % all commodities	UN Comtrade Database
Inter-regional trade hi_tech % all commodities	UN Comtrade Database
Energy price index (2005=100)	IMF Primary Commodity Prices
Crude oil price index (2005=100)	IMF Primary Commodity Prices
Natural gas price index (2005=100)	IMF Primary Commodity Prices
Non-energy commodity price index (2005=100)	IMF Primary Commodity Prices
Agricultural commodity price index (2005=100)	IMF Primary Commodity Prices
Raw materials price index (2005=100)	IMF Primary Commodity Prices

Table A6.1: Log t Convergence Test Outputs (US dollar)

Field	Value	Max	Min
Club members	10x2 double	7	0
Clubs	2	2	2
Divergence Unit	[1;2;3;8;9;10]	10	1
Pure convergence	0	0	0
Club1	**Club2**	**Divergent Unit**	**Pure convergent**
4	6	1	0
5	7	2	
0	0	3	
0	0	8	
0	0	9	
0	0	10	
0	0		
0	0		
0	0		
0	0		

Table A6.2: Log t Convergence Test Outputs (International dollar)

Field	Value	Max	Min
Club members	10x2 double	9	0
Clubs	2	2	2
Divergence Unit	[1;2;3;8;10]	10	1
Pure convergence	0	0	0
Club1	**Club2**	**Divergent Unit**	**Pure convergent**
4	6	1	0
5	7	2	
9	0	3	
0	0	8	
0	0	10	
0	0		
0	0		
0	0		
0	0		
0	0		

1. Central Asia 2. East Asia 3.Eastern Europe 4.Latin America and the Caribbean 5.Middle East and North Africa 6.North America 7.Pacific Countries 8.South Asia 9.Sub-Saharan Africa 10.Western Europe

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CHAPTER 4: THE EFFECTS OF REGIONAL ECONOMIC INTEGRATION ON INCOME CONVERGENCE WITHIN LATIN AMERICA AND THE CARIBBEAN

This paper is a joint work with Dr. John Serieux. The author of this thesis had principal responsibility for all aspects of the paper while the co-author provided advice and reviews. The chapter is self-contained with its own abstract, introduction, conclusion and references.

ABSTRACT

Empirical studies investigating the effects of regional integration on the pattern of intra-regional convergence have expanded significantly over the last two decades. However, most studies focus on the impact of regional political and institutional arrangements and do not address the intra-regional economic interaction as a separate phenomenon. This essay seeks to address this research gap by examining the pattern of income convergence in Latin America and the Caribbean during the post-Bretton Woods period, and then attempting to determine whether any such convergence (or divergence), can be attributed to intra-regional or inter-regional flows. Specifically we applied sigma and log t convergence tests to determine the pattern of convergence and Autoregressive Distributed Lag (ARDL) models to analyze the relationship between regional income distribution and related intra and inter-regional economic flows such as flows of trade, capital and technology.

Using US dollars for the measurement of per capita GDP, the log t test indicates overall convergence of all (26) Latin American countries. When per capita GDP is measured in international dollars, the log t convergence test generates three convergence clubs (Club 1 with 12 countries; club 2 with 10 countries and club 3 with only two countries). Sigma convergence tests do not show any clear trends of convergence for the region of Latin America and the Caribbean and

each of its convergence clubs, regardless of the measurements used for per capita GDP. Our regression results indicate that most of the intra-regional and inter-regional flows have long run divergence effects except inter-regional export and import of high technology products.

4.1 INTRODUCTION

Though empirical studies on the pattern of intra-regional convergence have expanded significantly over the last two decades, most of these studies are confined to either the developed regions or some common trade organizations such as the OECD[54], EU[55], NAFTA[56], MERCOSUR[57] (Barro 1991, Ben-David 1993, Sanchez-Reaza and Rodriguez-Pose 2002, Madariaga 2003, Blyde 2005, Holme 2005, Camarero *et al.* 2002, 2008). Some studies on income distribution in less developed regions focus on the comparison of convergence performance across heterogeneous regions while others focus on the impact of regional trade agreements and pay little attention to the effects of intra-regional economic interaction outside of those arrangements (Bowman and Felipe 2001, Dobson and Ramlogan 2002, Dobson *et al*. 2003*, Parikh and Shibata 2004*[58], Galvao and Gomes 2007). In general, there is comparatively little known about the specific effects of

[54] Organization for Economic Co-operation and Development (OECD) is an international economic organization of more than 30 member countries founded in 1961 to stimulate economic progress and world trade.
[55] The European Union (EU) is a politico-economic union of 28 member countries that are primarily located in Europe
[56] The North American Free Trade Agreement (NAFTA) is an agreement signed by Canada, Mexico, and the United States, creating a trilateral rules-based trade bloc in North America.
[57] MERCOSUR is a sub-regional bloc comprising Argentina, Brazil, Paraguay, Uruguay and Venezuela. Its associate countries are Chile, Bolivia, Colombia, Ecuador and Peru. Observer countries are New Zealand and Mexico. Its purpose is to promote free trade and the fluid movement of goods, people, and currency.
[58] * For studies on the comparison convergence performance across heterogeneous regions

globalizing (intra-regional and inter-regional) flows on the pattern of intra-regional convergence in developing regions.

This essay seeks to fill the research gap by first examining the general pattern of income convergence (or divergence) in the post-Bretton Woods period and then trying to determine the likely impact of these intra and inter-regional flows on the pattern of convergence in Latin America and the Caribbean. The geographic region of Latin America and the Caribbean has some attractive features as a laboratory for our investigation. It is a typical developing region dominated by relatively diversified economies and has experienced a high degree of economic regionalization over the past three decades. Specifically, this essay will examine the pattern of income convergence/divergence in Latin America and the Caribbean during the post-Bretton Woods period, and attempt to determine whether any such convergence, or divergence, can be directly attributed to intra-regional flows.

To that effect, the paper is divided as follows: Section 2 reviews the relevant empirical literature; Section 3 presents the study methodology and data; Section 4 presents and analyzes the investigation results; and Section 5 concludes the paper.

4.2 REVIEW OF EMPIRICAL STUDIES ON THE PATTERN AND DETERMINANTS OF INTRA REGIONAL CONVERGENCE IN LATIN AMERICA AND THE CARIBBEAN

Of the limited number of empirical studies that have investigated the pattern of income convergence in developing regions, most have found that Latin America has performed better than other less developed areas. Using cross sectional data, Helliwell and Chung (1992) tested for beta convergence for 1960-1985 in several world regions

including Latin America and found that, after controlling for several variables, Latin American countries strongly converged, African countries weakly converged and Asian countries did not converge. Allowing for heterogeneous rates of convergence across countries, Dobson *et al*. (2003) used panel data (covering the period 1965 to 1995) and tested for beta convergence in Latin America, Asia and Africa and found similar results: conditional convergence for Latin America and Africa, but no convergence in Asia. Also, applying the panel data methodology, Parikh and Shibata (2004) tested for both beta and sigma convergence in Latin America, Asia and Africa from 1970 to 1999. They did not find any evidence of beta convergence for the regions of Latin America and Asia but found significant divergence for Africa.

There have also been attempts to test for income convergence among countries within sub-regional groupings in Latin America and the Caribbean. Using panel data, Bowman and Felipe (2001) tested both sigma and beta convergence for Latin America, South America, Central America and the Caribbean, and found that only South America exhibited beta-convergence as well as sigma-convergence, while the other sub-regions exhibited divergence. In another study, Galvao and Gomes (2007) investigated the occurrence of per capita income convergence in 19 Latin American countries. They applied a time series approach to test for stochastic convergence based on stationarity tests, while accounting for structural breaks. Galvao and Gomes's study found evidence in support of conditional stochastic convergence among 12 (out of 19) Latin American countries. Moreover, they found the evidence of stochastic convergence to be even stronger when analyzing South and Central American countries separately. The evidence discussed above supports the existence of strong convergence trends within small groups of economies that

are closely connected to each other both geographically and economically. This implies that economic and institutional regionalization might be contributing factors to the formation of convergence clubs in Latin America.

Compared to other developing regions, Latin America has experienced a relatively high degree of economic globalization and it could be seen as an early bird in terms of the starting point of participation. For many Latin American countries, trade liberalization started in the late 1960s or the early 1970s. In the early stages, some major economies like Brazil, México and Argentina started to abandon their import substitution policies, reduce tariffs and pursue export orientated policies. Other countries soon followed the example set by these early reformers (Baer and Gillis, 1981). Foreign capital inflows increased in a few upper-middle income Latin American countries in the 1950s. Later on in the 1970s, the favourable conditions in the international financial markets allowed many other Latin American countries to gain access to significant capital inflows (Reardon and Berdegue, 2002).

To investigate underlying factors behind Latin America and the Caribbean's convergence performance, some empirical studies started to investigate the effects of trade and finance liberalization but reached contradictory conclusions (De Gregorio, 1992; Dobson and Ramlogan, 2002; Astorga, Bergés and Fitzgerald, 2005; Holmes, 2005; Sanz-Villarroya, 2005).

As Slaughter (2001) noted, many of these studies examined the effects of international trade and capital flows mainly through a snapshot comparison of a group of countries in two different time periods, before and after the trade and financial liberalization. A potential limitation of this methodology is that it simply compares

convergence performance only during the period in which the countries are classified as closed or open and ignores all other factors which might also affect income convergence.

To avoid the pitfalls of the before and after methodology, Slaughter (2001) used a "difference in differences" approach, which compares the convergence pattern among the liberalizing countries before and after liberalization with the convergence pattern among a control group of countries. He found that trade liberalization tended to cause incomes to diverge in Europe and North America. Similarly, Parikh (2004) used the "difference in differences" approach to examine the impact of trade and financial liberalization on convergence of per capita real incomes in Africa (30 countries), Asia (14 countries) and Latin America (20 countries). Using panel data, he tested for beta-convergence and sigma-convergence in each of the three regions. Liberalization was found to accelerate convergence in real per capita incomes for Asian and Latin American economies. For African countries however, liberalization had the opposite effect, with the real per capita incomes for each country diverging from the mean level of the region. In general, the real effects of trade and financial liberalization are still inconclusive but there is some evidence to support the notion that trade and financial liberalization could be contributory factors affecting the pattern of intra-regional convergence.

On the other hand, some researchers have turned to the examination of the effects of institutional factors, such as free trade agreements, common markets and integration movements on the pattern of regional income convergence. The number of free trade agreements and common markets among Latin American countries has grown significantly since the 1980s. Among them, MERCOSUR (1985) is the most significant in terms of its geographical coverage, the size of the economy covered, and the population of its member

countries. Other regional integration arrangements are the Andean Community of Nations (Andean Pact), the Latin American Integration Association (LAIA), the Central American Common Market(MCCA), and the Caribbean Common Market(CCM).

Dobson and Ramlogan (2002) compared the convergence performance of Latin America as a whole region before and after the formation of some major trade agreements, such as MECOSUR and MCCA. What they found suggests that trade agreements have had negative effects on intra-regional income convergence.

Other scholars started to investigate the effects of free trade agreements on the pattern of convergence among member countries. Madariaga (2003) tested the pattern of per capita income convergence within MERCOSUR and the results suggest sigma and absolute beta-convergence among member countries from 1985 to 2000. Using panel data, Holmes (2005) applied cointegration tests for stochastic convergence among members of MCCA and LAIA respectively. A stronger convergence trend was confirmed among MCCA members over the period 1960-2000 while a weaker form of convergence was found in the case of LAIA over the period 1981-2000. These studies seem to support the view that free trade agreements promote convergence among members.

However, this conclusion has been challenged by other empirical studies. Blyde (2005), using a panel data approach, tested for sigma and beta convergence within MERCOSUR and MCCA, from 1990 to 2001. He did not find any evidence of either sigma or beta convergence among member countries, except for two convergence clubs within MERCOSUR: one large club for low and lower-middle income countries and one small club for upper-middle income countries. Blyde's findings are corroborated by the work of

Camarero *et al* (2008). Camarero *et al*. used a multivariate approach to test for stochastic convergence among MERCOSUR countries for the period 1960-1999. Their results indicate that even though the smaller countries were advancing to the level of Brazil and, to some extent, Argentina, there was no evidence of convergence between the two large economies.

Actually these mixed results are not unexpected. According to the second best trade theory, these free trade agreements (FTAs) promote intra-group trade flows among member countries and, to some extent, reduce group trade flows between a member country and its external partners. The effects of the FTAs largely depend on the net effect of intra- and inter-group flows. The theoretical literature previously reviewed in Chapter 2 suggests that intra- and inter-group effects may be different across regions and vary over times, therefore the net effect could be inconclusive.

4.3 METHODOLOGY AND DATA

4.3.1 Convergence Club Identification

As was noted in the theoretical literature review (Chapter 2), sigma convergence tests, beta convergence tests, pair-wise stochastic convergence tests and Log t convergence tests have all been used to uncover patterns of both universal convergence and club convergence. The sigma convergence test, as a typical static convergence measure, is simple, visually easy to interpret and uncontested but it can only be applied to a pre-determined group of countries. The log t test, though more complex, is based on similar principles and affords the possibility of endogenously determining club membership when club convergence is identified. Moreover, the log t convergence test can also identify club membership even when club members are still on their own transitional paths.

In this chapter, we employ the sigma and log t convergence tests first to find evidence of universal convergence and then to identify convergence clubs (the more likely possibility) in Latin America and the Caribbean during the post-Bretton Woods period (1970-2010). The sigma convergence test has also been applied here for comparison.

4.3.1.1 Sigma Convergence Tests

A systematic decrease in the dispersion of country incomes is referred to as sigma convergence. It is typically measured by changes in the standard deviation of the log of per capita incomes across countries. A declining standard deviation of the log of per capita incomes across countries implies convergence and an expanding standard deviation would suggest divergence. In this essay, we first filter data to remove the effects of business cycles, and then calculate the natural logarithm of per capita income for each country in the Latin American and Caribbean regions. We then plot the serial values of standard deviation for the whole region and for each of the convergence clubs[59]. If the hypothesis of sigma convergence is true, we would expect to see a persistent downward trend in the variable. If, instead, divergence is occurring then we would expect to see a persistent upward trend.

4.3.1.2 Log t Convergence Tests

Following Phillips and Sul (2007), the logarithm of the per capita GDP for region *i* at time period *t*, $logy_{it}$, can be written as:

[59] The convergence clubs will be identified by the log t convergence tests in the following section

$$logy_{it} = \delta_{it}\mu_t \quad (1)$$

In the above equation, μ_t is the common growth path and δ_{it} represents the share of the common growth path that country *i* undergoes.

In order to specify the null hypothesis of convergence, Phillips and Sul (2007) further decompose δ_{it} into two parts:

$$\delta_{it} = \delta_i + \frac{\sigma_i \xi_{it}}{L(t)t^{\alpha}} \quad (2)$$

where δ_i does not vary over time, σ_i denotes country-specific parameter, ξ_{it} is an *iid* (0,1) random variable, L(t) is a slowly varying function *(*such that $L(t) \to \infty$ as $t \to \infty$*)* and α is the decay rate.[60]

The null and alternative hypotheses of convergence can be written as:

H_0 : $\delta_i = \delta$ for all *i* and $\alpha \geq 0$

H_A : $\delta_i \neq \delta$ for all *i* or $\alpha < 0$

Under the null hypothesis of convergence, long run convergence can be reached through different transitional paths, including catch up, common trend, or even temporary divergence, which refers to periods when $\delta_{it} \neq \delta_{jt}$.

The relative transitional coefficient for country i at time period t, h_{it}, represents the transitional path of country i relative to the cross section average.

[60] Here the slowly varying function ensures that convergence may occur even if the decay rate is zero.

$$h_{it} = \frac{logy_{it}}{N^{-1}\sum_{i=1}^{N} logy_{it}} = \frac{\delta_{it}}{N^{-1}\sum_{i=1}^{N} \delta_{it}} \quad (3)$$

The cross-sectional variance of h_{it}, denoted by V_t^2

$$V_t^2 = N^{-1}\sum_i (h_{it} - 1)^2 \quad (4)$$

In the case of convergence, all countries move toward a common path, $h_{it} = 1$ for all *i,* as $t \to \infty$, and V_t^2 converges to zero as $t \to \infty$. In the case of no overall convergence, there are a number of possible outcomes for V_t^2. It may converge to a positive number, which is the case for club convergence, or remain positive but not converge to any number (which rejects the existence of convergence clubs), or explosively diverge.

Substituting δ_{it} by $\delta_i + \frac{\sigma_i \xi_{it}}{L(t)t^{\alpha}}$ in equation (3), Phillips and Sul (2007) show that under convergence, V_t^2 will satisfy the following condition:

$$V_t^2 \sim \frac{A}{L(t)^2 t^{2\alpha}} \qquad \text{as } t \to \infty \text{ for } A > 0 \quad (5)$$

From equation (5), Phillips and Sul (2007), starting with the cross-sectional variance ratio (V_1^2/V_t^2) and, taking logs, and rearranging terms, specify the following equation from which the log t convergence test can be derived:

$$\log\frac{V_1^2}{V_t^2} - 2\log L(t) = c + b\log t + \mu_t \quad (6)$$

$$t = rT, rT+1, \ldots, T \text{ for } r \in (0,1)$$

here -2logL(t) is a penalty term and c refers to a constant term. Under the null of convergence, the estimate of the parameter b is 2α (here α represents the decay rate as we mentioned before). According to Phillips and Sul (2009), the role of the penalty term is to

improve the test's discriminatory power between overall convergence and club convergence. The condition $r \in (0,1)$ ensures that the first r% of time series data is discarded. This data trimming focuses the test on the latter part of the sample data and helps to validate the regression equation in terms of the tendency to converge.

Based on Monte Carlo results, Phillips and Sul (2007) suggest L (t) = log t and r = 0.3 for sample sizes below T = 50. Then, using $b = 2\alpha$, they suggest a one-sided t-test for the null hypothesis $\alpha \geq 0$. The null hypothesis of convergence is rejected if $t_{\hat{b}} < -1.65$ at the 5% significance level.

Before applying log t convergence test, we first filter the data to remove the effects of the business cycle using the Hodrick-Prescott smoothing filter, as suggested by Phillips and Sul (2007). Following Bartkowska and Riedl (2012), if convergence is rejected for the overall sample, the four step clustering test procedure below will be applied to subgroups of countries to identify convergence clubs in Latin America and the Caribbean.

- First, sort the real per capita GDP of all countries in time descending order.
- Second, identify the first convergence club by grouping the first two richest countries in the region and then use the log t test to determine whether they belong to a convergence club and continually add more countries to the group as long as the null hypothesis is not rejected.
- Third, conduct the log t tests between group members and remaining countries in the sample one by one to check if some of the group members are involved in two or more convergence clubs.

- In the final step, the first three steps are applied to the remaining countries to check if some of these countries are converging to their own clubs or simply diverging from each other.

The log t test procedure has been programed in Matlab by Bartkowska and Riedl, and the codes are applied in this chapter with permission.

4.3.2 Determining the Factors Affecting Regional Convergence in Latin America and the Caribbean

4.3.2.1 The Distributed Lag Regression

As was noted in the empirical review, compared to other less developed areas, the region of Latin America and the Caribbean has experienced a high degree of intra- and inter-regional economic activities and some evidence of intra-regional convergence. To determine whether there is any correlation between economic globalization and intra-regional income convergence, we investigate the relationship between intra-regional flows and one of the measures used in convergence tests – S_t the standard deviation of regional income dispersion used in the sigma convergence test.[61] [62]

In that regard, we specify a regression equation (7) with the dependent variable of S_t and two sets of independent variables, namely, basic factors (X_t) and international (globalizing) factors (Z_t).

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[61] Actually $S_t / \bar{y}$ equals the cross- country standard deviation of h_{it} derived from the log t convergence test.

[62] It is important to note that these regressions will not tell us whether these flows are the cause of convergence or divergence but whether they generate impulses that promote convergence or divergence.

$$S_t = \alpha + \sum_1^p \beta_i S_{t-i} + \sum_1^m \gamma_j X_{t-j} + \sum_1^n \delta_k Z_{t-k} + \varepsilon_t \quad (7)$$

Where ε_t is a random "disturbance" term.

The model is "autoregressive", in the sense that S_t is "explained (in part) by lagged values of itself. It also has a "distributed lag" component, in the form of successive lags of the explanatory variables (X and Z).

The X variables consist of basic factors that both the theoretical and empirical literature have identified as being associated with national and (therefore) regional economic growth. These variables include: the growth rates of physical capital, human capital and the labour force. The Z variables include relevant international factors that are thought to affect the process of regionalization such as intra- and inter-regional trade, capital and technology flows, and the global commodity prices relevant to countries' terms of trade.

Related theoretical models and empirical evidence suggest that a strong positive relationship exists between the country-level X variables and (country level) output growth. For that reason, the distribution of these X variables, in terms of relative magnitude across countries, can influence regional convergence (or divergence). To capture the effects of the relative distribution of these variables, for each year, we divide all countries in Latin America and the Caribbean into two categories: a high income group, consisting of members with per capita income above the average and a low income group, with income below the average.

We use X_H and X_L to denote the set of X variables for the high- and low-income country groups respectively. Although related growth models suggest that X_h and X_L should have almost non-differentiated effects on regional economic growth, they are expected to have opposite effects on the pattern of intra-regional convergence. For instance, all else being equal, capital accumulation in the relatively low-income group accelerates the economic growth within that group. This will reduce the income difference between the two groups, thus leading to regional income convergence. On the other hand, capital accumulation in the relatively high-income group promotes this group's economic growth, increasing income differences, and thus promoting regional income divergence. In addition, if the underlying production function do not exhibit constant returns to scale, X_H and X_L may have group specific effects on economic growth and, therefore, regional income distribution. For example, the equivalent rate of investment, with decreasing returns, will generate faster growth in the low income group than in the high income group while the equivalent rate of growth in investment with increasing returns will create the opposite result.[63]

To accommodate this distribution effect, the X variables will enter the regression equation as group specific variables X_H and X_L.

$$\gamma X = \gamma_h X_{ht} + \gamma_L X_{Lt} \qquad (8)$$

[63] In effect, the coefficients for X_H and X_L will not only have opposite signs but they may also have different absolute magnitudes.

The parameters γ_h and γ_L are the expression of different effects of X_{ht} and X_{Lt} on regional income distribution (S_t).

Related theoretical models (neoclassical growth models, neoclassical trade models, new trade models, structuralist north-south models etc.) suggest that the international factors (Z variables) have differentiated effects on individual partner countries. However, there is disagreement on the nature of the effect of these variables. For instance, neoclassical models suggest poor countries benefit more than their rich partners from experiencing these international flows while structuralist models predict the opposite result. Consequently, Z variables may directly contribute to the intra-regional convergence or divergence. In contrast to the X variables, the Z variables enter the regression equation without group division.

The international factors are classified into intra- and inter- regional flows and relevant global commodity prices. As was noted in Chapter 2, the intra-regional flows are expected to have either positive or negative effects on intra-regional convergence depending on the theoretical model under consideration. By contrast, whether or not the inter-regional flows have any effects on the pattern of intra-regional convergence may depend on the relative effects across regional partners. Global commodity prices are also expected to have differentiated effects on country-level growth and, therefore, affect the pattern of intra-regional convergence directly. For example, given that high income countries are likely to consume more energy products, a change in the price of energy may have stronger growth effects (positive or negative) on the relatively high income countries. Global commodity prices are approximated by the energy commodity price index, the non-

energy commodity price index, the price index for agricultural goods and the price index for raw materials.

4.3.2.2 Study Variables

As noted earlier the dependent variable (S_t) is measured as the standard deviation of regional income distribution. For the domestic independent variables for both high and low income groups (X_{ht} and X_{lt}), we follow standard practice in empirical work and use group average fixed capital formation rate (as a proxy for group physical capital growth), group average secondary school enrollment rate (as a proxy for the group rate of human capital accumulation), and group average rate of growth of the working age population (as a proxy for group labour force growth). The international independent variables (Z_t) include the intra- and inter-regional flows of goods and services, foreign direct investment (FDI) and portfolio investment, movement of high technique goods and services (a proxy for technology flows), and the global prices of commodities.

The intra-regional flows relative to GDP are measured as the regional average for all individual countries as are the ratios of hi-tech goods and services to intra-regional trade. The inter-regional flows are measured similarly.[64] The measures of global commodity prices used are the energy commodity price index, the non-energy commodity price index, agricultural price indices and the price index for raw materials. The list of variables is presented in Table A2 of the Appendix.

[64] Unlike intra-regional flows, inter-regional flows of imports and exports are not necessarily equal so they need to be measured separately.

4.3.2.3 Regression Technique

In order to apply the appropriate technique for regression analysis, we examined the stationary characteristics of the time series data in advance. We applied two types of stationary test to the relevant series. The first test by Kwiatkowski, Phillips, et al (1992) (henceforth the KPSS test) has a null of stationarity and it is better than other tests at distinguishing between persistent (near unit root) but stationary processes and unit root processes (Lee and Schmidt, 1996). The second test is the Generalized Least Squares (GLS) version of the Dickey-Fuller test developed by Elliot, et al (1996) (henceforth the DF-GLS test) test. The DF-GLS test (which has a null of non-stationarity) has high power in small samples (Elliot, G. et al, 1996). In this paper, a time series is accepted as stationary if the KPSS accepts the null hypothesis (of stationarity) and the DF-GLS rejects the null of non-stationarity – meaning that the two tests are in agreement. KPSS and DFGLS tests reveal that except for a few level variables, all the other variables are non-stationary but their first differences remain stationary.[65] Thus, except for the I(0) right-hand-side variables, the dependent and the majority of right-hand-side variables are I(1). There was no I(2) variable (see Appendix A3 and A4).

There are various techniques for conducting the cointegration analysis, for example, the residual based approach (Vector Error Correction Model-VECM) proposed by Engle and Granger (1987), the maximum likelihood-based approach proposed by Johansen et al. (1990, 1992) and the Augmented Autoregressive Distributed Lag (ARDL) approach

[65] The stationary variables are secondary school enrollment rate in high-income country group, the working age population growth rate in the low income group and the inter-regional inflow of portfolio investment.

proposed and augmented by Pesaran et al. (1998, 2001). Among them, both the VECM and the maximum likelihood approaches require the variables in the system to have the same order of integration. This requirement often causes difficulty when the system contains variables with different orders of integration as in this study. This makes the augmented ARDL the most practical of the three approaches in this case. The immediate advantages of the ARDL method are twofold:

- It is applicable irrespective of whether the underlying regressors are purely I(0), purely I (1) or mixed so long as there are no I(2) variables involved;
- It involves the estimation of a single equation to uncover both short run and long run coefficients, making it simple to implement and interpret.

Typically the traditional ARDL model (see equation (7)) was not considered applicable in the presence of I (1) variables. Pesaran et al. (1998) re-examine the use of ARDL models for the analysis of cointegrating relations among I(1) variables. They provide evidence that the ARDL based estimators are consistent with both short run and long run coefficients after appropriate argumentation of the ARDL model. By replacing level variables with their first differences and incorporating an error correction term ECT_{t-1} into a traditional ARDL model. Using the specification suggested by Pesaran et al. (2001), Equation (7) above becomes:

$$\Delta S_t = \alpha + \sum_1^p \beta_i \Delta S_{t-i} + \sum_1^m \gamma_j \Delta X_{t-j} + \sum_1^n \delta_k \Delta Z_{t-k} + \theta_0 ECT_{t-1} + e_t \quad (9)$$

Here, ECT_t, the error-correction term, is the OLS residuals series E_t from the long-run cointegrating regression:

$$S_t = -\frac{1}{\theta_0}\left(\theta_1 X_t + \theta_2 Z_t\right) + E_t \quad (10)$$

If we substitute $E_{t-1} = S_{t-1} + \frac{1}{\theta_0}\left(\theta_1 X_{t-1} + \theta_2 Z_{t-1}\right)$ for ECT_{t-1} in equation (9) the augmented version of ARDL model for this study becomes:

$$\Delta S_t = \alpha + \sum_1^p \beta_i \Delta S_{t-i} + \sum_1^m \gamma_j \Delta X_{t-j} + \sum_1^n \delta_k \Delta Z_{t-k} + \theta_0 S_{t-1} + \theta_1 X_{t-1} + \theta_2 Z_{t-1} + e_t \quad (11)$$

We can use equation (11) to estimate both the short run and long run effects that indicate the nature of the relationship between the standard deviation of regional income dispersion and each of its explanatory variables. The short run coefficients can be extracted directly from equation (11), they are γ and δ, the coefficients of lag difference variables. Noting that at long-run equilibrium, $\Delta S = 0$, $\Delta X = \Delta Z = 0$, the long-run coefficients for X and Z can be constructed by $-(\theta_1/\theta_0)$, $-(\theta_2/\theta_0)$respectively.

In this study, we supply ΔS_t as a left-hand-side variable. The right-hand-side variables are the intercept C, S_{t-1}, X_{t-1} and Z_{t-1}, and a fixed number of lags of ΔS_{t-1} $\Delta X_{t \text{ and }} \Delta Z_t$. We determine the lag orders by implementing a pre-estimation function for lag order selection (in Stata). These were determined by using four information criterion: the Final Prediction Error (FPE), the Akaike Information Criterion (AIC), the Hannan Quinn Informatin Criterion (HQIC) and the Schwarz-Bayesian Information Criterion (SBIC). These criteria are based on a high log-likelihood value, with a "penalty" for including more lags than necessary. The form of the penalty varies from one criterion to another. Each criterion starts with -2log(L), and then penalizes 2K, where L is the maximized value of the likelihood function for the model and K is the number of parameters in the model, therefore, the smaller the value of the information criteria the better and more “efficient”

the model. The order selection criteria of FPE, AIC, HQIC and SBIC suggested that optimal lags should be p=2, m=n=1 (see table 4-1).

Table 4-1 Lag Length Selection for P (when m=n=1)[66]

Lag	FPE	AIC	HQIC	SBIC
|0|	.000553	-5.41512	-4.93929	-4.06543
|1|	.000553	-5.55801	-5.06683	-4.16478
|2|	.00014*	-7.11264*	-6.60611*	-5.67587*

Optimal options are marked by *

We then perform the Bounds Test, developed by Pesaran et al. (2001)[67], to check for the existence of a long run equilibrium relationship among the level variables in equation (11). As in a conventional F-test, we test the linear hypotheses H_0: $\theta_0 = \theta_1 = \theta_2 = 0$, against the alternative that H_0 is not true and a rejection of H_0 will suggest a long run relationship. However, there is a practical difficulty when the F-test is conducted for a combination of I(0) and I (1) variables. Since the distribution of the test statistic is totally non-standard, exact critical values for the F-test are not available for a mix of I(0) and I(1) variables. To solve this problem, Pesaran et al. (2001) computed lower and upper bounds on the critical values for the asymptotic distribution of the F-statistic. The lower bound is based on the assumption that all of the variables are I(0), and the upper bound is based on the assumption that all of the variables are I(1). In fact, the true (critical) value will lie somewhere in between these two values. Therefore, if the computed F-statistic falls below the lower bound, we cannot reject the null hypotheses and the Bounds Test concludes that

[66] Table 3-1 indicates when m and n equal to 1, the optimal lag for p equals to 2, which is the best combination, any other values of m and n could not provide us with better result.

[67] Pesaran et al (2001) developed the Bound Testing for the existence of a level relationship between a dependent variable and a set of regressors irrespective of whether the underlying regressors are purely I(0), I(1) or mutually cointegrated.

no cointegrating relationship exists. If the F-statistic exceeds the upper bound, the Bonds Test concludes that a cointegrating relationship exists. Finally, if the F-statistic falls between the bounds, the test is inconclusive.[68]

For this study, we test the linear hypothesis that the coefficients of all level variables are jointly equal to zero after an appropriate version of the regression equation has been estimated.[69] The H_0 of joint zero coefficients was strongly rejected, which confirms the existence of a long run equilibrium relationship.[70]

The resulting equation was, nevertheless, quite large with several right-hand-side variables that might not belong in the equation – leading, potentially, to poor estimation results from over-parameterization. To develop a more parsimonious model, with better fit, we applied a general-to-specific approach as follows:

1. First estimate a model with all potential explanatory variables;[71]
2. Then eliminate the variable with highest p-value that is also greater than 0.1 (meaning that its coefficient is not significant);
3. Refit the model. If the information criteria become smaller or unchanged repeat Step 2. If the information criteria increases, replace the variable and repeat Step 2 for the variable with the next highest p-value (that is also greater than 0.1).

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[68] Since post-estimation linear hypothesis tests (in Stata) provide only chi2 statistics, we need to calculate the corresponding F statistics by dividing the degree of freedom of equation 11 and then apply upper and lower bounds to critical values of F tests.

[69] An appropriate version here means Equation 11 with optimal lags (based on the selection criteria).

[70] According to the linear hypothesis test output, chi2-statistic (15) equals to 88985.21 with zero probability which is equivalent to F-statistic(15) equals to 6356.09 with zero probability.

[71] In the case of variables that were very similar (such as some of the price indices) the best performing versions (based on both t-statistic and information criterion).

4. Repeat the process until all p-values are less 0.1 (coefficients are significant at the 10 percent level) or the removal of any remaining variable (regardless of the size of its t-statistic and p-values) will cause the information criterion to increase (meaning that there is a net "information" loss for excluding any remaining variable).

The ARDL methodology requires the errors of regression equations must be serially independent and normally distributed.[72] After regression, we apply LM tests for residual autocorrelation and a series of normality tests (Jarque-Bera test, Skewness test and Kurtosis test) for residual normal distribution. The result of the LM test (see appendix table A5) shows that the null hypothesis of no autocorrelation cannot be rejected given the optimal lag(s) of (2, 1, 1). None of the normality tests reject the null hypothesis of normally distributed disturbances, which is desirable (see appendix table A6).

For any models with autoregressive structure, we should check if the models are dynamically stable or not. More specifically, we need to make sure that all of the inverse roots of the characteristic equation associated with our model lie strictly inside the unit circle. The check of eigenvalue stability condition indicated that all the eigenvalues lie inside the unit circle, which means the ARDL model satisfies the stability condition (see appendix table A7).

[72] This requirement may also be influential in the final choice of maximum lags for variables in the ARDL models because the common solution to the issue of autocorrelation is to add more lags.

4.3.3 Data and Sources

Since most potential determinants of income distribution are measured in US dollars, for consistency, there is a need to use US dollar as a measurement of per capita income. However, the measurement with US dollar is subject to the fluctuation of market exchange rates. Another drawback of the US dollar measurement is that market exchange rates are relevant only for internationally traded goods (Callen, 2007). Usually the prices of nontraded goods are higher in developed countries than emerging and developing countries. Therefore the US dollar measurement is likely to overestimate the welfare of high income countries and underestimate that of low income countries. The measurement of per capita income with international dollar is based on the exchange rates derived from Purchasing Power Parity (PPP). The PPP based exchange rates are good at catching up with the differences in the prices of non-traded goods across countries (Callen, 2007). In addition, using international dollar to measure per capita income can minimize misleading comparisons that may arise with the fluctuation of market exchange rates. However, the PPP based exchange rate has its own weaknesses. The major one is the inaccuracies related to its measurement. PPP rates are generated by the International Comparisons Program (ICP), based on a global survey of prices (Callen, 2007). Since survey data are available only in benchmark years, in the years between, the PPP rates have to be extrapolated by varies methodologies. Also, the ICP's survey does not cover all countries, which means that data for missing countries need to be estimated. Therefore the two forms of measurements are likely to complement each other since they have different types of weaknesses.

In this study, all income variables are measured as nominal GDP per capita using both international (PPP) and US dollars respectively. The data on income in international dollars are derived from the Penn World Table 8.0(International Comparison of Prices Program, University of Pennsylvania). The data on income in US dollars are derived from the United Nation Data (UN data 2014). The data for other variables come from a variety of datasets produced by the International Monetary Fund, the OECD, the World Bank and the United Nations. All of the potential dependent and independent variables and corresponding data source are listed in appendix table A2.

4.4 RESULTS AND ANALYSIS

4.4.1 Convergence Test Results

4.4.1.1 Results from Log t Convergence Test

We applied the log t convergence test to investigate the presence of overall or club convergence in Latin America and the Caribbean during the post-Bretton Woods period (1970-2011) using UN data (for US dollar incomes) and Penn World Table (7.0) (for international dollar incomes).[73] The summarized test results are presented in table 4-2. Using US dollar as a measurement of nominal per capita GDP, the log t test reveals overall convergence for all of the 26 Latin American countries. When nominal per capita GDP is measured in international dollars, the log t convergence test generates three convergence clubs (club1 with 12 countries, club 2 with 10 countries and club 3 with only two countries).

[73] Please refer to Appendix table A9.1 and Appendix table A9.2 for log t convergence test outputs

Table 4-2 Convergence Club Identification

Per capita GDP is measured by current price, international dollars (Purchasing Power Parity) Data source: Penn World Table 7.0			
Club 1 (12 countries)	**Club 2** (10 countries)	**Club 3** (2 countries)	**Divergent Unit(s)**
Argentina	Bolivia	Haiti	Cuba
Bahamas	Brazil	Paraguay	Barbados
Costa Rica	Chile		
EI Salvador	Colombia		
Guatemala	Dominica republic		
Jamaica	Ecuador		
Mexico	Guayana		
Nicaragua	Honduras		
Peru	Panama		
Suriname	Uruguay		
Trinidad & Tobago			
Venezuela			
Per capita GDP is measured by current price, US dollars Data source: UN data			
Overall convergence for total 26 countries[74]			

Club 1 includes Argentina, Mexico, Venezuela, and a number of countries with relatively high or medium per capita GDP. Most countries in this club are in Central America and the Caribbean (Argentina and Venezuela are notable exceptions).

Club 2 includes Brazil, Chile and a number of countries with medium or low per capita GDP. Most countries in this club are in South America.

[74] See appendix A for a list of the 26 countries in our sample

Club 3 includes Haiti and Paraguay. These two countries have had very difficult economic histories over the past four decades.

Cuba and Barbados are found to diverge from all clubs. The divergence of Cuba may be partially explained by its special economic history and circumstances. Cuba was initially tied to the Soviet block till the dismantlement of that block in the late 80s. The country has also been subjected to US embargoes since the early 60s leading to rather difficult and unique economic circumstances. Barbados's divergence most likely stems from the specifics of its economic structure. This is a very small country with a strong off-shore banking system and a flourishing tourism industry. Its political, economic and human development profile resembles that of a developed country.

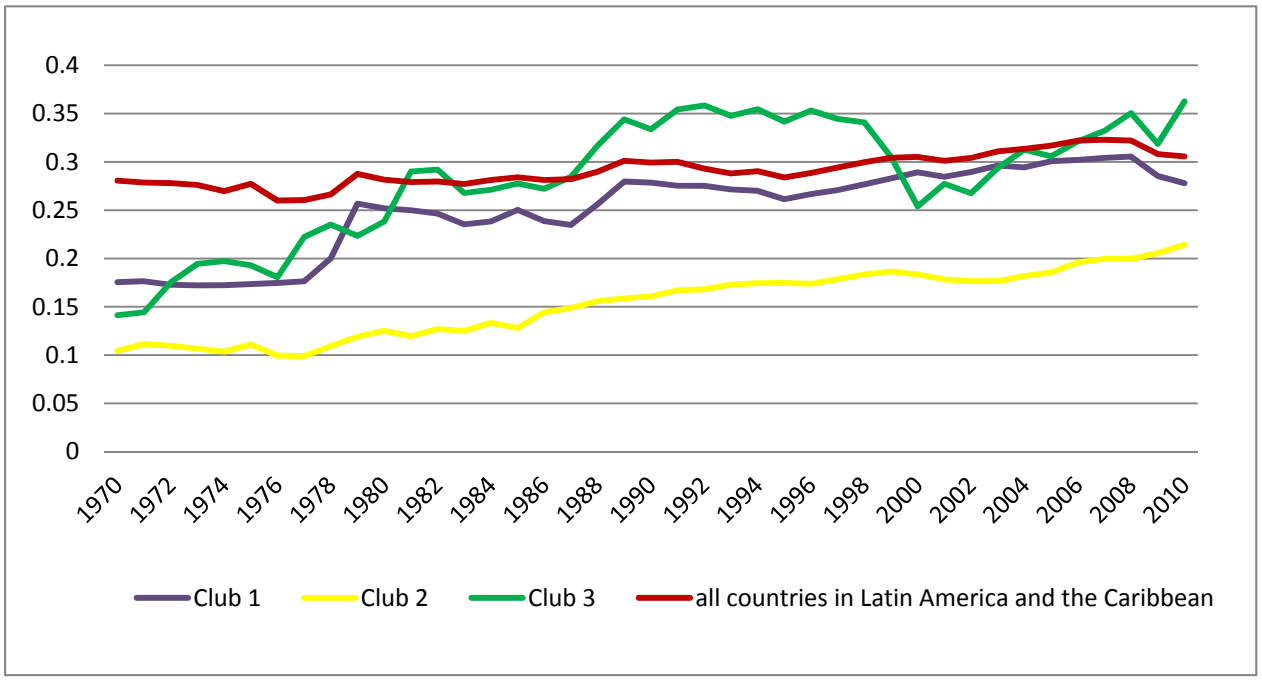
Due to the weaknesses of the two measurements (US dollars and international dollars) chosen for log t tests[75], each of the test results may deviate from the real pattern of convergence. Therefore, the discrepancy between the two tests with different measurements is not unexpected.

4.4.1.2 Sigma Convergence Test Results

As discussed earlier, GDP per capita has been measured by international and US dollars. The corresponding results from sigma convergence tests are slightly different and presented in figure 4-1 and figure 4-2 respectively.

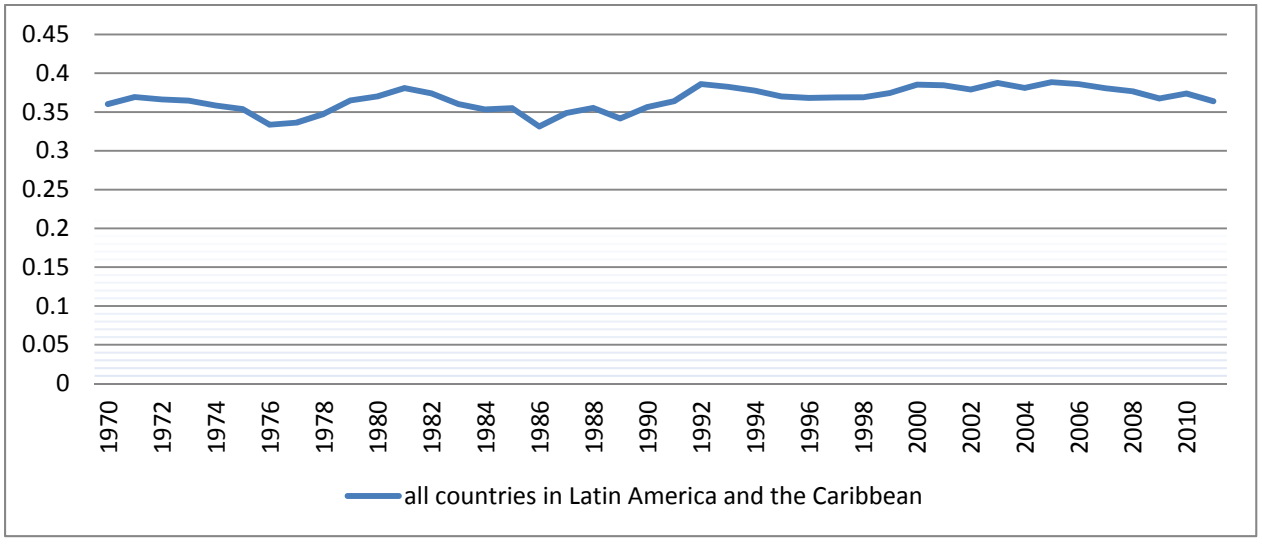
[75] Please refer to 4.3.3 (page 122) for details.

Figure 4-1 Standard Deviation of Log Per Capita GDP (in international dollar) across LAC Countries



Data source: Penn World table 7.0 (PPP Converted GDP Per Capita, at current price in International Dollar)

Figure 4-2 Standard Deviation of Log Per Capita GDP (in US dollar) across LAC Countries



Data source: UN data (GDP Per Capita, at current price in US Dollar)

Figure 4-1 and figure 4-2 indicate that, since 1970, the region of Latin America and the Caribbean has experienced patterns of both transitional divergence and convergence

regardless of whether the measure of per capita income is international (PPP) dollars or US dollars.

Figure 4-1(per capita GDP measured in international dollars) indicates a general trend of muted sigma convergence or slight divergence for the region of Latin America and the Caribbean. Club 1 and club 3 have similar sigma convergence trends, beginning with a sharp divergence period (until 1978) followed by a relatively stable or slight divergence period. The only difference is that club 1 has a mild trend while club 3 has a more fluctuated pattern. Club 2 is exceptional for its persistent mild divergence during the whole period of study. Figure 4-2 (per capita GDP measured in US dollars) shows a general stable period for the region of Latin America and the Caribbean – which would be consistent with a situation where growth convergence has already occurred.

We do not see consistent sigma convergence trends for any of the log t convergence clubs for the whole time period of study. This is not unexpected given the differences between the sigma test and the log t convergence test. Eliminating a fraction of early data, the log t convergence test allows for different transitional paths towards convergence while the sigma test does not really distinguish between short-term transitional dynamics and long term trends. With the slowly varying function L(t), the log t convergence test will not reject the hypotheses of convergence, even if the convergent rate equals zero (Phillips and Sul 2009). Both of these factors increase the log t test likelihood of finding convergence relative to the sigma test. If we look closely at figure 4-1 and figure 4-2, we will find that the result from the sigma convergence test is not wholly contradictory to that of the log t convergence test. For instance, although figure 4-1 fails to indicate sigma convergence

trends for any of the convergence clubs, it does not show any strong divergence trends after 1980. From 1970 to 1980, members in club1 and club 3 exhibited strong transitional divergence, which cannot be captured by the log t convergence test since the early year data have been discarded. The fact that figure 4-2 does not show any trends of sigma convergence or divergence is consistent with the result of growth convergence from log t tests.

4.4.2 Regression Output for the Determinants of the Pattern of Intra-Regional Convergence

The ARDL regression outputs presented in Appendix Table A8 reveal a number of long-run as well as short-run effects on the pattern of intra-regional convergence. Based on the regression result, the long run and short run coefficients are extracted and presented in in table 4-3-1 and table 4-3-2 respectively.

Table 4-3-1 Long Run Coefficients

Independent Variable Name	Coefficient
Constant term	-0.6722
Average fixed capital formation rate high income group	0.0808
Average fixed capital formation rate low income group	-0.0268
Average secondary education enrolment rate high income group	0.0141
Average secondary education enrolment rate low income group	-0.0235
Average working age population growth rate high income group	-0.1176
Average working age population growth rate low income group	-0.4938
intra-regional trade % GDP	0.1059
intra-regional FDI inflow % GDP	0.2878
intra-regional portfolio inflow % GDP	0.4098
intra-regional high-tech trade % all commodity	0.4098
inter-regional export %GDP	0.0504
inter-regional FDI inflow % GDP	0.4030
inter-regional portfolio inflow % GDP	0.0811
inter-regional high-tech export % all commodity	-0.6832
inter-regional high-tech import % all commodity	-0.1328
Energy price index	-0.0011

Table 4-3-2 Short Run Coefficients

Independent Variable Name	Coefficient
Average fixed capital formation rate high income group	0.0215
Average fixed capital formation rate low income group	0.0135
Average secondary education enrolment rate high income group	0.0030
Average secondary education enrolment rate low income group	-0.0086
Average working age population growth rate high income group	0.0208
Average working age population growth rate low income group	0.2039
intra-regional trade % GDP	-0.1534
intra-regional FDI inflow % GDP	-0.0215
intra-regional portfolio inflow % GDP	-0.0840
intra-regional high-tech trade % all commodity	0.0193
inter-regional export % GDP	0.0072
inter-regional import % GDP	0.0166
inter-regional FDI inflow % GDP	-0.0856
inter-regional high-tech export % all commodity	0.1992
Energy price index	-0.0008

4.4.2.1 Long Run Effects on Intra-regional Convergence

4.4.2.1.1 Determinants of Output

As expected, determinants of growth for the high income country group have divergent effects on the intra-regional distribution of income while the determinants for the low income group have convergent effects.[76] There is one exception, however. A higher working age population growth rate for the high-income group tends to reduce rather than

[76] A negative coefficient indicates convergent effects, because the standard deviation is getting smaller, while a positive coefficient indicates divergent effects because the standard deviation is getting larger.

expand the degree of dispersion of regional incomes. We suspect that, because the labour force participation rate in the richer countries was falling through much of that period, this measure is not a very good proxy for the rate of growth in employment and reflects population growth effects much more than employment growth.[77]

4.4.2.1.2 Trade Flows

According to our regression outputs, both intra-regional trade and inter-regional export flows have divergent effects on the intra-regional distribution of incomes, the inter-regional import flow turns out to be insignificant (it did not survive the general-to-specific estimation procedure). The effects of intra-regional trade and inter-regional exports are in line with the predictions of structuralist trade models where the core and semi-periphery countries are seen to be taking advantage of periphery countries (Wallenstein, 1974).[78] As a result, successfully industrializing countries[79] are able to move up the value chain and/or increase export volumes sufficiently to generate rapid growth while the less successful countries[80] have to depend on exporting primary products, thereby, benefiting less from trade.

[77] For instance, the labour force participation rate in Chile has been fluctuated around 55% since 1990 (data source from WDI World Bank).
[78] According to Wallenstein, intra-regional trade is likely to take place between semi-periphery and periphery countries and inter-regional export of primary goods is likely to come from periphery countries to their external core partners.
[79] Successful countries are likely from semi-periphery.
[80] Less successful countries are likely from periphery.

4.4.2.1.3 Capital Flows

Evidence in favour of the structuralist view also comes from the divergence effect of intra and inter-regional inflows of capital (both portfolio and FDI flows). Given the nature of portfolio investment, the divergent effect of portfolio inflows is not unexpected. It is well known that the development of financial markets must reach a threshold (in both size and sophistication) to ensure substantial portfolio inflows. For this reason, it is only relatively high-income countries that can benefit from the inflows of portfolio investment and consequently enhance their economic growth. This threshold effect has also been applied to the case of FDI inflows by Borensztein, Gregorio and Lee (1998)[81]. This general pattern is close to that predicted by the Wallenstein structuralist model which argues that capital flow from the core economies would benefit newly and semi-industrialized (semi-periphery) countries and not low income (periphery) countries.[82]

4.4.2.1.4 Technology Flows

Since we do not have direct measure of technology transfer, trade in high technology goods is used as a proxy indicator for technology transfer. The underlying presumption is that, increasing import of high technology goods multiplies the likelihood of spillover effects (if they are to occur). As well, the export of high technology goods by any

[81] In this study it is financial sector development, rather than human capital development, that determines the threshold.

[82] In the case of Latin America, the assumption that inter-regional capital flows come necessarily from the core economies is not a strong one since the major source of external capital is from North America and West Europe.

country is an indication that technological transfer has occurred.[83] The regression results indicate that inter-regional high-technology imports and exports have convergent impact on intra-regional income distribution. However, the intra-regional flow of trade in high-technology goods tends to increase the dispersion of intra-regional incomes.

The convergence effects of inter-regional technology transfer could be explained by structuralist technology evolution models (Posner 196I, Freeman 1963, Hufbauer 1966 and Vernon 1966). These models suggest that the evolution of a new technology involves three distinct phases. Initially new technology starts in the core economies with sufficient physical and human capital stock. Over time, the technology evolves into a mature phase, characterized by standardized production. In this latter phase, international competition is based on cost reduction, therefore, the technology will be transferred to periphery economies with relatively cheap labour. Usually the core economies benefit from technology innovation while periphery economies benefit from imitation and diffusion (Cimoli, 1988, 1998). For the case of Latin America and the Caribbean, the inter-regional technology transfer is likely to occur in low income countries instead of middle income countries since low income countries are considered to have relatively cheap labour and raw materials. Therefore, the beneficiaries of inter-regional technology transfer could be those countries with relatively lower income. As a result, inter-regional flows of technology will help intra-regional income convergence.

[83] We assume, along with most of the theoretical and empirical literature, that little (frontier) technological innovation takes place outside the advanced economies.

The positive correlation between the volume of intra-regional trade in high technology products and regional income dispersion is probably due to the fact that the former is actually an indicator of the latter. The region of Latin America and the Caribbean consists of no advanced economy and has only emerging and developing economies, hence, presumably the intra-regional technology gap is not wide enough to generate an evolutionary process. For this reason, the intra-regional flows of trade in high technology products are likely among countries with relatively high income. A higher volume of intra-regional technology flows implies a faster growth in relatively high income countries and consequently a wider dispersion of regional income.

4.4.2.1.5 Global Price Indices

Many of the global commodity price indices proved to be insignificant and did not survive the general-to-specific estimation procedure except the energy commodity price index. Our regression output indicates that the energy commodity price index has long run convergence effects. This is probably due to the existence of different exporting and importing structures in the region of Latin America. Relatively low income countries focus on the export of energy or energy-related products while relatively high income countries export high value added products for which energy is a major input and therefore import energy products. For this reason, an increase in the energy commodity price index is likely to be in favour of relatively low income countries and against high income countries - thus, promoting intra-regional convergence.

4.4.2.2 Short Run Effects on Intra-regional convergence

The short run effects of growth factors are slightly different from corresponding long run effects. Capital formation in the low income group has un-favourable short run effects on intra-regional convergence as opposed to the convergent long run effects of capital formation in low income countries. This can be explained by the nature of capital accumulation as a long term investment, especially for developing countries[84]. Another exception is that the working age population growth in low income group has divergent short run effects on intra-regional convergence. This is likely due to the fact that in the short run, population growth could slow down per capita output growth because its immediate impact on output growth is relatively weak. Since the population of poorer countries is typically growing faster than that of richer countries, the 'slow down' effect can be expected to be more pronounced for low income countries.

In contrast to the long run, most of the intra-regional flows have convergent short run effects[85], which seem to be consistent with the prediction of neoclassical models (Barro, Menkiw and Sali-I-Martin 1995, Easterly 2005). However, it may not be contradictory to the structuralist models. For instance, according to Merican (2009), structuralists do not dispute that FDI inflows bring returns to receiving countries, but the returns are expected to be reduced by "differential productivity". Differential productivity is the expected result of several disturbances from foreign investments including tax avoidance, less development of local entrepreneurship, inappropriate technology, less profit reinvestment,

[84] This is probably because of related threshold effects in low income countries.
[85] The flow of intra-regional trade in high technology is an exception.

and less linkage to domestic business (Firebaugh 1992, Dixon and Boswell 1996). For low income countries, these adverse effects of foreign investment are mainly related to the long run rather than the short run[86]. Therefore, the convergent short run effects of intra-regional flows are not surprising from the structuralists' viewpoint.

The convergence short run effect of inter-regional FDI flows (compared to the divergence long-run effect) is likely derived from the fact that adverse effects of FDI are stronger in the long run than in the short run[87]. The divergence short run effects of inter-regional export in high-technology goods (compared to the convergence long-run effects) could be explained by the fact that the gestation period for technology imitation and diffusion is longer in a relatively low income country than it is in a relatively high income country(Acemoglu 2003, Birdsall 2008, Jaumottee et al. 2013). Therefore, in the short run, the flows of inter-regional export in high-technology goods are presumed mainly from relatively high income countries within the region. Since the short run beneficiaries of technology transfer are likely to be countries with relatively high income, the increasing flow of inter-regional high-tech export will indicate intra-regional divergence.

The short run effects of energy commodity price indices are similar to its long run effects probably for the same reason mentioned in 4.2.1.5.

[86] For details, please refer to Chapter 2 (2.3.5)
[87] This is similar to the case of intra-regional FDI flows.

4.5 CONCLUSION

Though empirical studies on the pattern of intra-regional convergence have expanded significantly over the last two decades, most of these studies are confined to either the developed regions or to some common trade organizations such as the OECD, EU, NAFTA, MERCOSUR. A few studies on income distribution in less developed regions focus on the impact of regional trade agreements. In general, there is comparatively little known about the specific effects of intra and inter-regional flows on the pattern of intra-regional convergence in developing regions.

We therefore sought to fill the research gap by examining the impact of these regional flows on the pattern of convergence in Latin America and the Caribbean. The geographic region of Latin America and the Caribbean has some attractive features as a laboratory for our investigation. It is a typical developing region dominated by relatively diversified economies and has experienced a high degree of economic regionalization over the past three decades.

In this study, we first examined the pattern of income convergence in Latin America and the Caribbean during the post-Bretton Woods period, and then analyzed its potential determinants. Specifically, using time series data, we applied sigma and Log t convergence tests for the pattern of convergence and autoregressive distributed lagged (ARDL) models to analyze the relationship between regional income dispersion and related factors. We investigated the effects of intra and inter-regional flows of trade, capital and technology for

the short run and long run respectively. Our main findings are summarized in the following paragraphs.

Using international dollars as the measure for nominal per capita GDP, the log t convergence test generated three clubs (Club 1 with 12 countries; club 2 with 10 countries and club 3 with only two countries). Club 1 includes Argentina, Mexico, Venezuela, and a number of countries with relatively high or medium per capita GDP. Many countries in this club are from Central America and the Caribbean with the exception of Argentina and Venezuela. Club 2 includes Brazil, Chile and a number of countries with medium or low per capita GDP. Most countries in this club are in South America. Club 3 includes Haiti and Paraguay, the two relatively low income countries in our sample. Using US dollars as the measure for nominal per capita GDP, the log t test revealed an overall convergence trend for all of the 26 Latin American countries.

Regardless of the measure used for per capita income, the sigma convergence tests indicated no obvious trend of convergence or divergence for the region and each of the three convergence clubs identified by the log t test over the period of study.

Based on our regression analysis, both domestic and international factors are related to the pattern of intra-regional income convergence. As expected, most of the domestic factors (determinants of growth) for the high income country group have divergent effects on the intra-regional distribution of income while those for the low income group have convergent effects. These observations applied to both the short run and the long run.

International factors consist of intra- and inter-regional flows of trade, capital, technology and related global price indices. The effects of intra-regional flows are in line with the predictions of stucturalist models. The flow of intra-regional trade in high technology products has divergent effects on regional income dispersion for both the short run and the long run. Other intra-regional flows such as intra-regional trade, FDI and portfolio flows have divergent long run effects.

With respect to inter-regional flows, most of them have divergent effects on intra-regional income dispersion for both the short run and the long run, which may be well explained by north-south structuralist models.[88] The flows of inter-regional import and export in high technology products are exceptional for having convergent long run effects. The convergent long-run effects of inter-regional technology transfer are in line with the prediction of structuralist technology evolution models (Posner 196I, Freeman 1963, Hufbauer 1966 and Vernon 1966).

Our regression output indicates that the energy commodity price index has convergent effects for both the short run and the long run. This is likely due to the existence of different importing and exporting structures across countries in the region of Latin America and the Caribbean.

[88] Please refer to 2.3.4 North South Growth Models in Chapter 2

APPENDIX

Table A1: Country Sample

Latin American and Caribbean Countries Included in the Sample
1. Argentina
2. Bahamas
3. Barbados
4. Bolivia
5. Brazil
6. Chile
7. Colombia
8. Costa Rica
9. Cuba
10. Dominican Republic
11. Ecuador
12. El Salvador
13. Guatemala
14. Guyana
15. Haiti
16. Honduras
17. Jamaica
18. Mexico
19. Nicaragua
20. Panama
21. Paraguay
22. Peru
23. Suriname
24. Trinidad & Tobago
25. Uruguay
26. Venezuela

Table A2: Variable List and Data Source

Potential Dependent and Independent Variables	Data Source
Coefficient of variation of intra-regional per capita GDP distribution (GDP measured in US dollars)	United Nation Statistic Division, UN data 2014
Coefficient of variation of intra-regional per capita GDP distribution (GDP measured in international dollars)	Penn World Table 7.0, University of Pennsylvania
Gross fixed capital formation (% GDP)_High income	World Development Indicator, World Bank
Gross fixed capital formation (% GDP)_Low income	World Development Indicator, World Bank
Secondary school enrollment rate _High income	World Development Indicator, World Bank
Secondary school enrollment rate _Low income	World Development Indicator, World Bank
Growth rate of working age population _High income	World Development Indicator, World Bank
Growth rate of working age population _Low income	World Development Indicator, World Bank
World export % gdp	UN Comtrade Database
Inter-regional export % gdp	UN Comtrade Database
World import % gdp	UN Comtrade Database
Inter-regional import % gdp	UN Comtrade Database
Intra-regional trade % gdp	UN Comtrade Database
World FDI inflow % gdp	OECD Stat
Inter-regional FDI inflow % gdp	OECD Stat
Intra-regional FDI inflow % gdp	OECD Stat
World portfolio inflow % gdp	OECD Stat
Inter–regional portfolio inflow % gdp	OECD Stat
Intra–regional portfolio inflow % gdp	OECD Stat
World import hi_tech % all commodities	UN Comtrade Database
Inter-regional import hi_tech % all commodities	UN Comtrade Database
World export hi_tech % all commodities	UN Comtrade Database
Inter-regional export hi_tech % all commodities	UN Comtrade Database
World trade hi_tech % all commodities	UN Comtrade Database
Inter-regional trade hi_tech % all commodities	UN Comtrade Database
Energy price index (2005=100)	IMF Primary Commodity Prices
Crude oil price index (2005=100)	IMF Primary Commodity Prices
Natural gas price index (2005=100)	IMF Primary Commodity Prices
Non-energy commodity price index (2005=100)	IMF Primary Commodity Prices
Agricultural commodity price index (2005=100)	IMF Primary Commodity Prices
Raw materials price index (2005=100)	IMF Primary Commodity Prices

Table A3: Unit Root Tests for Dependent and Potential Explanatory Variables

Variable Name (in level)	KPSS null of stationary		Augmented DF null of unit root(s)	
	level	trend	level	trend
Stdevs/mean (per capita GDP measured in US dollars)	.516*	.207*	-1.635	-1.574
Stdevs/mean (per capita GDP measured in PPP dollars)	.107	.106	-1.563	-2.099
Gross fixed capital formation (% of GDP)_High income	.372	.206*	-2.299*	-2.227
Gross fixed capital formation (% of GDP)_Low income	.192	.0604	-2.628*	-3.724*
Change in school enrollment rate _High income	.273	.0405	-2.299*	-2.227
Change in school enrollment rate _Low income	.171	.119	-3.799**	-4.729**
Change in population ages 15-64 (% of total)_High income	.113	.0422	-4.271**	-4.301**
Change in population ages 15-64 (% of total)_Low income	.046	.039	-1.182*	-3.910**
World export % gdp	1.21**	.181*	-0.639	-3.405*
Inter-regional export % gdp	1.14**	.155*	-1.816	-3.349*
World import % gdp	1.24**	.248**	-1.78	-2.994
Inter-regional import % gdp	1.17**	.228*	-1.872	-3.166*
Intra-regional trade % gdp	1.31**	.275**	0.191	-2.789
World FDI inflow % gdp	1.13**	.154*	-1.551	-2.283
Inter-regional fdi inflow % gdp	.836**	.106	-1.624	-2.320
Intra-regional fdi inflow	1.11**	.147	-1.247	-2.258
World portfolio inflow % gdp	.21	.103	-2.681**	-2.803
Inter–regional portfolio inflow % gdp	.145	.0759	-3.066**	-3.172
Intra–regional portfolio inflow % gdp	.231	.102	-2.872**	-2.984
World import hi_tech % all commodity	1.44**	.166*	-0.708	-2.334
Inter-regional import hi_tech % all commodity	1.43**	.161*	-0.661	-2.296
World export hi_tech % all commodity	1.48**	.0819	-0.545	-2.115
Inter-regional export hi_tech % all commodity	1.1**	.0653	-1.459	-2.248
World trade hi_tech % all commodity	1.51**	.182*	-0.619	-1.872
Inter-regional trade hi_tech % all commodity	1.5**	.178*	-0.474	-1.769
Intra-regional trade hi_tech % all commodity	1.51**	.203*	-1.491	-2.118
Energy price index (2005=100)	.834**	.229**	0.609	-1.283
Crude oil price index (2005=100)	.817**	.235**	0.654	-1.238
Natural gas price index (2005=100)	1.06**	.222**	-0.781	-2.144
Non-energy commodity price index (2005=100)	.745**	.163*	0.612	-2.733
Agricultural commodity price index (2005=100)	.57*	.133	0.218	-2.856
Raw materials price index (2005=100)	1.13**	.0992	1.168	-3.295*

* rejected at 5%
** rejected at 1%

Table A4: Unit Root Tests for First Difference of Dependent and Potential Explanatory Variables

Variable Name (in first difference)	KPSS null of stationary		Augmented DF null of unit root(s)	
	level	trend	level	trend
Stdevs/mean (per capita GDP measured in US dollars)	.251	.132	-2.116*	-2.427
Stdevs/mean (per capita GDP measured in PPP dollars)	.128	.103	-2.492*	-2.737
Gross fixed capital formation (% of GDP)_High income	.0671	.0713	-4.091**	-4.000**
Gross fixed capital formation (% of GDP)_Low income	.0482	.194*	-4.795**	-5.413**
Change in school enrollment rate _High income	.0736	.0596	-6.172**	-5.338**
Change in school enrollment rate _Low income	.0904	.0691	-4.927**	-4.450**
Change in population ages 15-64 (% of total)_High income	.0712	.0709	-4.380**	-4.837**
Change in population ages 15-64 (% of total)_Low income	.057	.0498	-5.270**	-6.207**
World export % gdp	.138	.111	0.017	-2.579
Inter-regional export % gdp	.141	.105	-0.339	-3.500*
World import % gdp	.109	.116	-2.799**	-2.778
Inter-regional import % gdp	.1	.106	-2.955*	-2.939
Intra-regional trade % gdp	.0838	.0901	-2.721**	-2.697
World FDI inflow % gdp	.111	.11	-1.680	-3.417*
Inter-regional fdi inflow % gdp	.0484	.0484	-4.042**	-4.048**
Intra-regional fdi inflow	.0988	.0968	-3.514**	-4.375**
World portfolio inflow % gdp	.0602	.058	-6.227**	-6.245**
Inter–regional portfolio inflow % gdp	.0628	.0583	-3.819**	-4.005**
Intra–regional portfolio inflow % gdp	.0716	.0645	-4.168**	-4.440**
World import hi_tech % all commodity	.125	.12	-3.852**	-3.975**
Inter-regional import hi_tech % all commodity	.115	.11	-3.830**	-3.951**
World export hi_tech % all commodity	.121	.0989	-3.215**	-3.355*
Inter-regional export hi_tech % all commodity	.118	.0696	-3.274**	-2.857
World trade hi_tech % all commodity	.143	.143	-4.426**	-4.704**
Inter-regional trade hi_tech % all commodity	.125	.125	-4.547**	-4.794**
Intra-regional trade hi_tech % all commodity	.175	.127	-3.606**	-4.035**
Energy price index (2005=100)	.209	.119	-2.969**	-3.119
Crude oil price index (2005=100)	.223	.119	-2.866*	-2.986
Natural gas price index (2005=100)	.082	.0706	-2.256*	-2.333
Non-energy commodity price index (2005=100)	.177	.135	-3.110**	-3.262*
Agricultural commodity price index (2005=100)	.149	.137	-3.287**	-3.460*
Raw materials price index (2005=100)	.137	.109	-2.975**	-3.001

* rejected at 5%
** rejected at 1%

Table A5: Lagrange-Multiplier Test for Auto Correlation

Test Hypotheses	No auto correlation at lag order:		
Test Output	**chi2**	**df**	**Prob>chi2**
lag (1)	2.0663	1	0.15059
lag (2)	0.0858	1	0.76963

Table A6: Tests for Normally Distributed Disturbances

Test Hypotheses	disturbances are normally distributed		
Test Output	**chi2**	**df**	**Prob>chi2**
Jarque-Beratest			
D_UNVNF	1.156	1	0.56098
ALL	1.156	1	0.56098
Skewness			
D_UNVNF	1.049	1	0.30563
ALL	1.049	1	0.30563
Kurtosis			
D_UNVNF	0.107	1	0.74397
ALL	0.107	1	0.74397

Table A7: Eigen Value Stability Condition Test

Eigen Value		**Modulus**
.07672398	+ .7112401i	.715366
.07672398	+ .7112401i	.715366

Table A8: ARDL Regression Outputs LA

Sample: 1975-2011 No. of obs = 37
Log likelihood= 164.5838 AIC= -7.112637
FPE= .0001402 HQIC= -6.606111
Det (Sigma_ml)= 8.01e-06 SBIC= -5.675873

Equation	RMSE	R-sq	chi2	P>chi2
D_S	0.00861	0.9965	10538.48	0.000
Var.	**Coef.**	**Std.Err.**	**z**	**P>|z|**
S				
LD.	0.153448	0.0247798	6.19	0.000
L2D.	-0.511749	-0.511749	-12.16	0.002
GFCFH				
LD	0.0215178	0.0015335	14.03	0.000
GFCFL				
LD	0.0134885	0.0017688	7.63	0.000
CSEH				
LD	-0.0030052	0.0005113	-5.88	0.000
CSEL				
LD	-0.0085561	0.0011622	-7.36	0.000
CWPH				
LD	0.02081	0.0025561	8.14	0.000
CWPL				
LD	0.2038942	0.0101213	20.15	0.000
TEERPG				
LD	0.0071617	0.0013873	5.16	0.055
TIERPG				
LD	0.0166273	0.0015447	10.76	0.000
TRAPG				
LD	-0.1533845	0.0093825	-16.35	0.006
FERPG				
LD	-0.08563	0.0061061	-14.02	0.000
FRAPG				
LD	-0.02152	0.0032886	-6.54	0.000
PRAPG				
LD	-0.0840062	0.0054534	-15.4	0.000
HTEERPA				
LD	0.1991734	0.008066	24.69	0.000
HTRAPA				
LD	0.0193481	0.001857	10.42	0.000
EPI				
LD	-0.000841	0.0001162	-7.03	0.000
S				
L1.	-0.3591674	0.0627301	-5.73	0.000

GFCFH				
L1.	0.0290323	0.0016699	17.39	0.000
GFCFL				
L1.	-0.0096379	0.0030788	-3.13	0.000
CSEH				
L1.	0.0050767	0.0011182	4.54	0.300
CSEL				
L1.	-0.0084532	0.0025083	-3.37	0.000
CWPH				
L1.	-0.0422483	0.0030675	-13.77	0.000
CWPL				
L1.	-0.1773594	0.0114552	-15.48	0.000
TEERPG				
L1.	0.0180851	0.0030204	5.99	0.000
TRAPG				
L1.	0.0380267	0.0055973	6.79	0.000
FERPG				
L1.	0.1447559	0.0093536	15.48	0.000
FRAPG				
L1.	0.1033756	0.006762	15.29	0.000
PERPG				
L1.	0.0291426	0.0036295	8.03	0.017
PRAPG				
L1.	0.147196	0.0094094	15.64	0.000
HTIERPA				
L1.	-0.0476908	0.0023342	-20.43	0.042
HTEERPA				
L1.	-0.2453871	0.0092309	-26.58	0.000
HTRAPA				
L1.	0.0098829	0.0024982	3.96	0.000
EPI				
L1.	-0.0003951	0.0005113	-5.68	
_cons	-0.6722271	0.0509276	-13.2	0.000

Table A9.1: Log t Convergence Test Outputs (US dollar)

Field	Value	Max	Min
Club members	26x0	26	0
Clubs	0	0	0
Divergence Unit	0	0	0
Pure convergence	1	1	1

1. Argentina 2. Bahamas 3. Barbados 4. Bolivia 5. Brazil 6. Chile
7. Colombia 8. Costa Rica 9. Cuba 10. Dominican Republic 11. Ecuador

12. El Salvador 13. Guatemala 14. Guyana 15. Haiti 16. Honduras 17. Jamaica
18. Mexico 19. Nicaragua 20. Panama 21. Paraguay 22. Peru 23. Suriname
24. Trinidad & Tobago 25. Uruguay 26. Venezuela

Table A9.2: Log t Convergence Test Outputs (International dollar)

Field	Value		Max	Min
Club members	26x3		26	0
Clubs	3		3	3
Divergence Unit	[3;9]		9	3
Pure convergence	0		0	0
Club1	**Club2**	**Club3**	**Divergent Unit**	**Pure convergent**
1	4	15	3	0
2	5	21	9	
8	6	0		
12	7	0		
13	10	0		
17	11	0		
18	14	0		
19	16	0		
22	20	0		
23	25	0		
24	0	0		
26	0	0		
0	0	0		
0	0	0		
0	0	0		
0	0	0		
0	0	0		
0	0	0		
0	0	0		
0	0	0		
0	0	0		
0	0	0		
0	0	0		
0	0	0		
0	0	0		
0	0	0		
0	0	0		

1. Argentina 2. Bahamas 3. Barbados 4. Bolivia 5. Brazil 6. Chile
7. Colombia 8. Costa Rica 9. Cuba 10. Dominican Republic 11. Ecuador
12. El Salvador 13. Guatemala 14. Guyana 15. Haiti 16. Honduras 17. Jamaica
18. Mexico 19. Nicaragua 20. Panama 21. Paraguay 22. Peru 23. Suriname
24. Trinidad & Tobago 25. Uruguay 26. Venezuela

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CHAPTER 5: THE EFFECTS OF INTRA-REGIONAL TRADE AND FINANCIAL FLOWS ON THE PATTERN OF INCOME CONVERGENCE IN EAST AND SOUTH-EAST ASIA

This chapter is self-contained with its own abstract, introduction, conclusion and references.

ABSTRACT

Empirical studies on the pattern of intra-regional convergence have expanded significantly over the last two decades. However, most studies focus on the impact of regional political and economic agreements and do not address the intra-regional flows of trade, capital, labour and technology as a separate phenomenon. This essay seeks to address this research gap by examining the pattern of income convergence in East and South-East Asia during the post-Bretton Woods period, and then attempting to determine whether any such convergence, or divergence, can be attributed to intra-regional flows.

Specifically we applied sigma and log t convergence tests for the pattern of convergence and an Autoregressive Distributed Lag (ARDL) model to analyze the relationship between regional income distribution and related intra and inter-regional flows.

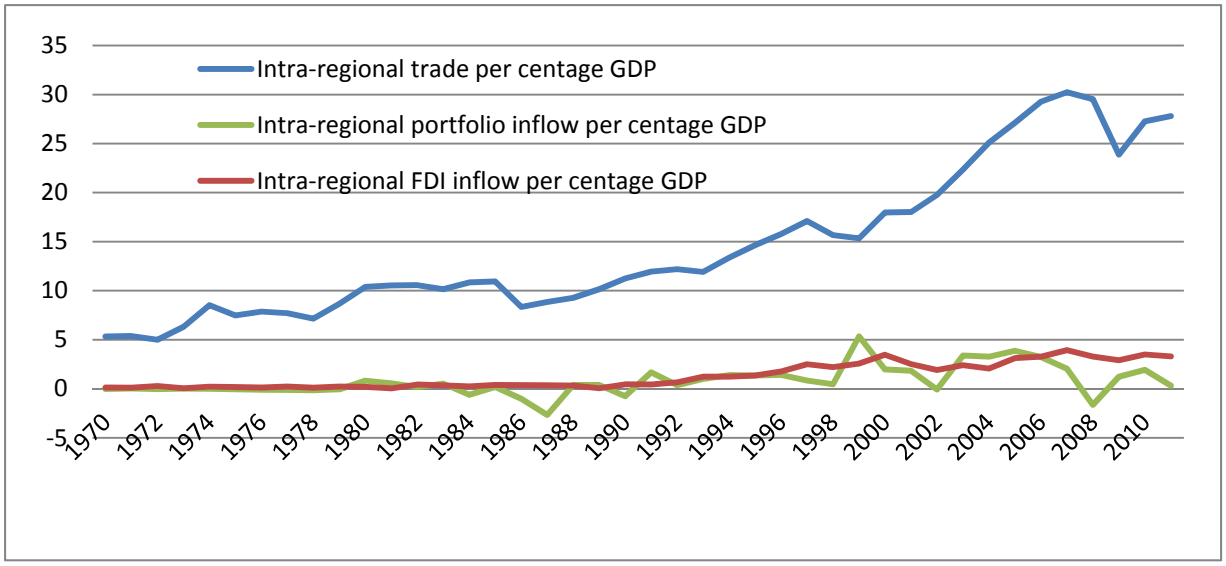
In this chapter, the log t convergence test identifies the existence of two convergence clubs within the region of East and South-East Asia, which, to some extent, is supported by the sigma convergence tests. Our regression results indicate that each individual flow affects the pattern of intra-regional income convergence differently and, sometimes, even the same flow may have different short run and long run effects. However,

in general, intra-regional trade, especially intra-regional trade in high-technology goods promotes income convergence across countries in East and South-East Asia.

5.1 INTRODUCTION

The Region of East and South-East Asia has been experiencing significant levels of economic regionalization over the past two decades (see figure5-1). The engines of economic regionalization in East and South-East Asia come, at least in part, from the explosive growth of regional supply chains, which go beyond (and often precede) formal economic or political arrangements (such as multiple-country free trade agreements, common markets etc.). In this case, the impacts of economic regionalization on the degree of income convergence/divergence will depend on the effect of increased intra-regional trade, investment and technology flows (in addition to any effect inter-regional flows). Yet, the specific effects of intra-regional flows on the pattern of income convergence/divergence in East and South-East Asia have remained largely unexplored.

Figure 5-1 Intra-regional trade, FDI and portfolio flows for the region of East and South-East Asia



Data source: OECD Statistics and IMF e-Library Data

This essay seeks to address this research gap by examining the impact of these intra-regional flows on the pattern of intra-regional convergence in East and South-East Asia. Specifically, the essay will begin by examining the pattern of income convergence in East and South-East Asia during the post-Bretton Woods period, and then attempt to determine whether any part of such convergence, or divergence, can be attributed to intra-regional flows.

To that effect, the paper is divided as follows: Section 2 below presents relevant empirical literature review; Section 3 presents the study methodology and data; Section 4 presents and analyzes the investigation results; and Section 5 concludes the paper.

5.2 REVIEW OF EMPIRICAL STUDIES ON INTRA REGIONAL CONVERGENCE AND ITS DETERMINANTS RELEVANT OF EAST AND SOUTH-EAST ASIA

In East and South-East Asia, the relatively rapid growth rate and wide disparity in per capita incomes (ranging from $65,475 in Brunei to $2,393 in Cambodia according to the 2010 PWT database) has attracted the interest of both policy makers and researchers. Not surprisingly, researchers have sought to determine whether this wide disparity has been stable, growing or contracting. The results have been mixed. Some scholars find no tendency to converge in the region of East and South-East Asia. Felipe (2000) examined the convergence performance of 16 Asian countries and found no tendency to convergence, with respect to both income level convergence and catch up, from 1970 to 2000. Park (2000) examined intra-southeast Asia income convergence and did not find any evidence of convergence as well. Mathur (2005) tested the beta convergence hypotheses for selected European Union (EU), South and East Asian and Commonwealth of Dependent States (CIS)

countries from 1961-2001. Although his results provide evidence of absolute convergence for EU and East Asian countries (grouped together), countries within the East Asia region do not show any tendency toward beta convergence. Other scholars argue that although there is no tendency toward overall convergence for the whole region over relatively long time periods, there are signs of club convergence for small groups of countries during some specific time periods. Park (2003) examined the pattern of income convergence in the Asia Pacific region during 1960-2000, and did not find any evidence of convergence for the entire period. However, the empirical note did provide support for the Asia Pacific region constituting a convergence club in the latter part of the period. Zhang (2001) found evidence of the existence of multiple convergent clubs across 10 selected East Asian economies in 1960–1997. He further predicted the possibility for these East Asian countries to catch up with the leader country (Japan) in the long run. Haider et al (2010) tested for income convergence across selected economies in East and South Asia. Their empirical work shows the presence of conditional convergence for the group of East and South Asian economies during the period from 1973 to 2009.

Researchers have also investigated factors that could drive regional economic growth. Empirical studies suggest international trade and finance flows are closely related to rapid growth. Michelis and Neaime (2004) provided empirical evidence that openness to international trade is statistically an important variable for sustaining economic growth in the Asia-Pacific region. Similarly, Sachs et.al (1997) and Acharya (2008) found a positive relationship between openness in trade and finance and productivity growth in East and South-East Asia.

According to our theoretical review in Chapter2, the pattern of intra-regional convergence largely depends on growth distribution instead of economic growth itself. Rapid economic growth may not have any effects on intra-regional convergence if it is dispersed evenly across countries. Given the wide range in the current distribution of regional incomes, only uneven growth across economies could change the pattern of intra-regional convergence.

Feenstra (1996) investigated the possibility that international trade might lead to uneven growth. According to him, international trade may lead to a divergence of growth rates across countries if no diffusion of knowledge occurs simultaneously. To the contrary, Fukuda and Toya (1995) argued that the rapid growth in East Asia should be largely attributable to its export-oriented economies and, given the export-GDP ratios, subsequent growth rates in East Asian countries would be negatively related to their initial levels of per capita GDP. Zhang (2001) analyzes the impact of trade and FDI on East Asian income convergence by incorporating additional variables representing exports and FDI into the standard equation of beta convergence test. With the inclusion of exports and FDI, the speed of convergence slightly improved for the period from 1960 to 1996. This partly explains the role of free trade and FDI in promoting income convergence. Using difference in differences approach, Tayebi (2009) compared intra-regional convergence rates pre- and post- trade liberalization in East Asia (which occurred mostly in the 1980s and 1990s). He found a positive relationship between trade liberalizations and intra-regional convergence.

Recently, some researchers have turned to the examination of the effects of institutional factors on income convergence among member countries in East and South-East Asia. Such institutional factors usually include intra-regional trade associations, regional trade agreements (RTAs), and other formal arrangements. The results from empirical studies on intra-regional trade associations are not conclusive. Using unit root tests for Pair-Wise income convergence, Lim and Mcaleer (2000) did not find any evidence of convergence between pairs of the Association of South-East Asian Nations (ASEAN5). Lim and Mcaleer (2004) using the unit root and cointegration techniques to test income convergence among the ASEAN-5 countries also did not find any evidence of convergence. Michelis and Neaime (2004) tested for income convergence in the Asia-Pacific Economic Cooperation (APEC), and its subsets of East Asia and ASEAN during two periods 1960-1990 and 1960-1999. For the former period, the evidence of conditional beta convergence was found for a group of 17 APEC countries and for 10 East Asian countries. No evidence of income convergence was found for the group of ASEAN countries. For the latter period, there was weak evidence of conditional beta convergence in a group of 16 APEC countries, and much weaker evidence of income convergence in East Asia. Ismail (2008) investigated the issues of convergence and economic growth in the ASEAN5. His empirical evidence supports the unconditional and conditional convergence hypotheses in the ASEAN5 for the period of 1960-2004. Moreover, the ASEAN5 countries tended to converge to a steady state growth rate of per capita GDP with a speed of convergence of between 1.6% and 16.6%. Sperlich, S., and Sperlich, Y. (2012) investigated the effects of South-South regional integration agreements (RIAs) on economic growth and convergence among member countries in three regions (Latin America, South-East Asia, and Africa) respectively. Their

findings show a positive impact on growth and income convergence for member countries in most of the considered integration areas. Jayanthakumaran and Lee (2013) investigated income convergence patterns of the ASEAN and the South Asian Association of Regional Cooperation (ASSRC). Applying cointegration tests for stochastic convergence (time series analysis), they found evidence of convergence for ASEAN 5 countries but not for ASSRC 5 countries. Similarly, Solarin et al (2014) examined the existence of income convergence trends among the ASEAN and SAARC countries for the period covering 1970–2009. They applied unit root tests with structural break(s) for stochastic convergence and β-convergence tests. Their test results show the existence of income convergence among ASEAN members and the absence of convergence in SAARC members, which corroborates the findings of Jayanthakumaran and Lee.

Park (2006) analyzed the effects of East Asian RTAs. He argues that, these RTAs promote trade flows among member countries and, to some extent, reduce the trade flows between a member country and its non-regional partners. The former is related to the effect of trade creation and the latter to trade diversion. Whether RTAs promote economic growth (in a member country) or not will largely depend on the net effect of trade creation and trade diversion. Park's argument about the net effect of trade creation and diversion can also be applied to the case of intra-regional trade associations. Since the net effect varies across member countries (depending on their pattern of trade), the RTAs and intra-regional economic associations are likely to generate uneven growth and thereby an effect on the pattern of intra-group convergence. Since the pattern of uneven growth (caused by RTAs or intra-regional economic associations) may not correlate with initial income of

member countries[89], the impacts of these institutions on the pattern of convergence among member countries may not be conclusive.

Other scholars have examined the pattern of convergence between ASEAN and external economies. Lim, Azali and Lee (2005) applied unit root tests for the catching up process between Japan and each of the ASEAN5 economies for the period 1960 to 1997. Their test results did not show any of the ASEAN countries converging to Japan. Lau and Lee (2008) used a simple correlation analysis to test for the interdependence of income between China and each of the ASEAN5 countries and reached an opposite result. Their findings suggest ASEAN5 countries have highly correlated growth with China. They suggest that two main factors could explain the growth correlation between ASEAN5 and China. First China has increased its cooperation with members of ASEAN-5 through trade and investment facilitation policies (Chirathivat 2002). Second under the framework of cooperation with China, the FDI inflows into member countries have been enhanced, as these Asian countries are producers of inputs for the Chinese manufacturing sector (Eichengreen and Tong 2006).

From the above, some empirical studies simply focus on the performance of convergence without looking at the process that might be generating it and others look at the effects of intra-regional institutional arrangements. Few of them investigate the specific effects of intra and inter-regional flows of trade, capital, technology and labour.

[89]Depending on the pattern of trade, a member country may either benefit or lose from these regional trade arrangements regardless of its income level.

However, intra-regional economic activities in East and South-East Asia are largely due to the market-driven forces that appear to be reinforced, rather than generated, by institutional factors. The effects of intra-regional trade, FDI and technology are likely to have been crucial to the pattern of income convergence (or divergence) over the last few decades.

5.3 METHODOLOGY AND DATA

5.3.1 Choice of Convergence Tests

As was noted in the theoretical literature review (Chapter 2), sigma convergence tests, beta convergence tests, pair-wise convergence tests and Log t convergence tests have all been used to uncover patterns of both universal convergence and club convergence. The sigma convergence test, as a typical static convergence measure, is simple, visually easy to interpret and uncontested but it can only be applied to a pre-determined group of countries. The log t test, though more complex, is based on the same principles and affords the possibility of endogenously determining club membership when club convergence is identified. Moreover, the log t convergence test can also identify club membership even when club members are still on their own transitional paths.

In this chapter, we employ the sigma and log t convergence tests first to find evidence of universal convergence and then to identify convergence clubs (the more likely possibility) in East and South-East Asia during the post-Bretton Woods period (1970-2011). The sigma convergence test provides evidence of level convergence experienced in the past, while, the log t convergence test attempts to identify potential convergence trends.

5.3.1.1 Sigma Convergence Tests

A systematic decrease in the dispersion of country incomes is referred to as sigma convergence. This is typically equated with a declining standard deviation of the log of per capita incomes across countries. By contrast, an expanding standard deviation would suggest divergence. In this essay, we first filter data to remove the effects of business cycles, then calculate the natural logarithm of per capita income for each country in the region of East and South-East Asia and plot the serial values of standard deviation for the whole region and each of the convergence clubs[90] respectively. If the hypothesis of sigma convergence is true, we would expect to see a persistent downward trend in the variable. If, instead, divergence is occurring then we would expect to see a persistent upward trend.

5.3.1.2. Log t Convergence Tests

Following Phillips and Sul (2007), the logarithm of the per capita GDP for region *i* at time period *t*, $logy_{it}$, can be written as:

$$logy_{it} = \delta_{it}\mu_t \qquad (1)$$

In the above equation, $\mu_t$is the common growth path and δ_{it} represents the share of the common growth path that country *i* undergoes.

In order to specify the null hypothesis of convergence, Phillips and Sul (2007) further decompose δ_{it} into two parts:

$$\delta_{it} = \delta_i + \frac{\sigma_i \xi_{it}}{L(t)t^{\alpha}} \qquad (2)$$

[90] The convergence clubs will be identified by the log t convergence tests in the following section

where δ_i does not vary over time, σ_i denotes country-specific parameter, ξ_{it} is an *iid* (0,1) random variable, L(t) is a slowly varying function *(*such that $L(t) \rightarrow \infty$ as $t \rightarrow \infty$*)* and α is the decay rate.[91]

The null and alternative hypotheses of convergence can be written as:

H_0 : $\delta_i = \delta$ for all *i* and $\alpha \geq 0$

H_A : $\delta_i \neq \delta$ for all *i* or $\alpha < 0$

Under the null hypothesis of convergence, long run convergence can be reached through different transitional paths, including catch up, common trend, or even temporary divergence, which refers to periods when $\delta_{it} \neq \delta_{jt}$.

The relative transitional coefficient for country i at time period t, h_{it}, represents the transitional path of country i relative to the cross section average.

$$h_{it} = \frac{logy_{it}}{N^{-1}\sum_{i=1}^{N} logy_{it}} = \frac{\delta_{it}}{N^{-1}\sum_{i=1}^{N} \delta_{it}} \quad (3)$$

The cross-sectional variance of h_{it}, denoted by V_t^2

$$V_t^2 = N^{-1}\sum_i (h_{it} - 1)^2 \quad (4)$$

In the case of convergence, all countries move toward a common path, $h_{it} = 1$ for all *i,* as $t \rightarrow \infty$, and V_t^2 converges to zero as $t \rightarrow \infty$. In the case of no overall convergence, there are a number of possible outcomes for V_t^2. It may converge to a positive number, which is

[91] Here the slowly varying function ensures that convergence may occur even if the decay rate is zero.

the case for club convergence, or remain positive but not converge to any number (which rejects the existence of convergence clubs), or explosively diverge.

Substituting δ_{it} by $\delta_i + \frac{\sigma_i \xi_{it}}{L(t)t^{\alpha}}$ in equation (3), Phillips and Sul (2007) show that under convergence, V_t^2 will satisfy the following condition:

$$V_t^2 \sim \frac{A}{L(t)^2 t^{2\alpha}} \qquad \text{as } t \to \infty \text{ for } A > 0 \tag{5}$$

From equation (5), Phillips and Sul (2007), starting with the cross-sectional variance ratio (V_1^2/V_t^2) and, taking logs, and rearranging terms, specify the following equation from which the log t convergence test can be derived:

$$\log \frac{V_1^2}{V_t^2} - 2 \log L(t) = c + b \log t + \mu_t \tag{6}$$

$$t = rT, rT+1, \ldots, T \text{ for } r \in (0,1)$$

here -2logL(t) is a penalty term and c refers to a constant term. Under the null of convergence, the estimate of the parameter b is 2α (here α represents the decay rate as we mentioned before). According to Phillips and Sul (2009), the role of the penalty term is to improve the test's discriminatory power between overall convergence and club convergence. The condition $r \in (0,1)$ ensures that the first r% of time series data is discarded. This data trimming focuses the test on the latter part of the sample data and helps to validate the regression equation in terms of the tendency to converge.

Based on Monte Carlo results, Phillips and Sul (2007) suggest L (t) = log t and r = 0.3 for sample sizes below T = 50. Then, using $b = 2\alpha$, they suggest a one-sided t-test for the null

hypothesis $\alpha \geq 0$. The null hypothesis of convergence is rejected if $t_{\hat{b}} < -1.65$ at the 5% significance level.

Before applying log t convergence test, we first filter the data to remove the effects of the business cycle using the Hodrick-Prescott smoothing filter, as suggested by Phillips and Sul (2007). If convergence is rejected for the overall sample, the four step clustering test procedure will be applied to subgroups of countries to identify convergence clubs in East and South-East Asia (as suggested by Bartkowska and Riedl 2012):

- First, sort the real per capita GDP of all countries in descending order.
- Second, identify the first convergence club by grouping the first two richest countries in the region and then use the log t test to determine whether they belong to a convergence club and continually add more countries to the group as long as the null hypothesis is not rejected.
- Third, conduct the log t tests between group members and remaining countries in the sample one by one to check if some of the group members are involved in two or more convergence clubs.
- In the final step, the first three steps are applied to the remaining countries to check if some of these countries are converging to their own clubs or simply diverging from each other.

The log t test procedure has been programed in Matlab by Bartkowska and Riedl, and the codes are applied in this chapter with permission.

5.3.2 Determining the Factors Affecting Regional Convergence in East and South-East Asia

5.3.2.1 The Regression Equation

Intra-regional per-capita income convergence, if it occurs, necessarily derives from uneven growth across countries, in particular, growth that favours lower income countries. The last forty years have witnessed not only rapid growth in East and South-East Asia but also increasing levels of integration among the region's economies. To determine whether that increased level of intra-regional flows has generated any tendency toward convergence, we investigate the relationship between these flows and one of the measures used in convergence tests – S_t the coefficient of variation of regional income dispersion used in the sigma convergence test.[92] [93] In that regard, we specify a regression equation (7) with the dependent variable of S_t and two sets of independent variables, namely, basic factors (X_t) and international (globalizing or regionalizing) factors (Z_t).

$$S_t = C + \sum_1^p \beta_i S_{t-i} + \sum_1^m \gamma_j X_{t-j} + \sum_1^n \delta_k Z_{t-k} + \varepsilon_t \qquad (7)$$

where ε_t is a random "disturbance" term.

The model is "autoregressive", in the sense that S_t is explained (in part) by lagged values of itself. It also has a "distributed lag" component, in the form of successive lags of the explanatory variables (X and Z).

[92] Actually $S_t / \bar{y}$ equals the cross- country standard deviation of h_{it} derived from the log t convergence test.

[93] It is important to note that these regressions will not tell us whether these flows are the cause of convergence or divergence but whether they generate impulses that promote convergence or divergence.

The X variables consist of basic contributors thought to be associated with national and (therefore) regional economic growth (according to both the theoretical and empirical literature). These contributors include the nature of growth of physical capital, human capital and the labour force. The Z variables include relevant international factors, which are thought to affect the process of regionalization, such as regional aggregate international flows of trade, capital and technology, and the global commodity prices relevant to countries' term of trade.

Evidence from theoretical and empirical literature suggests that a strong positive relationship exist between the country-level X variables and (country level) output growth. For that reason, how these variables are distributed, in terms of relative magnitude across countries, can influence regional convergence (or divergence). To capture the effect of the relative distribution of these variables, for each year, we divide all countries in East and South-East Asia into two categories: a high income group, consisting of members with per capita income above the average and a low income group, with income below the average. We use X_H and X_L to denote the set of X variables for the high- and low-income country groups respectively. Although related growth models suggest that X_h and X_L should have almost non-differentiated effects on the rate of regional economic growth, they are expected to have opposite effects on the pattern of growth and, therefore, intra-regional convergence. For instance, all else being equal, capital accumulation in the relatively low-income group accelerates the economic growth within that group. This will reduce the income differential between the two groups, thus leading to regional income convergence. On the other hand, capital accumulation in the relatively high-income group promotes this group's economic growth, increasing income differences, and thus promoting regional

income divergence. In addition, if the underlying production functions do not exhibit constant returns to scale, X_H and X_L may have group specific effects on economic growth and, therefore, regional income distribution. For example, the equivalent rate of investment, with decreasing returns, will generate faster growth in the low income group than in the high income group while the equivalent rate of growth in investment with increasing returns will create the opposite result.[94]

To accommodate this distribution effect, the X variables will enter the regression equation as group specific variables X_H and X_L.

$$\gamma X = \gamma_H X_{Ht} + \gamma_L X_{Lt} \quad (8)$$

The parameters γ_H and γ_L are indicators of the different effects of X_{Ht} and X_{Lt} on regional income dispersion (S_t).

Related theoretical models such as neoclassical growth models, neoclassical trade models, new trade models and structuralist north-south models suggest that the international factors (Z variables) have differentiated effects on individual partner countries. However, there is profound disagreement on the nature of the effect of these variables. For instance, neoclassical models suggest that these international flows provide a greater benefit to poor countries compared to their rich partner countries while structuralist models predict the opposite result. Consequently, Z variables may directly

[94] In effect, the coefficients for X_H and X_L will not only have opposite signs but they may also have different absolute magnitudes.

contribute to the intra-regional convergence or divergence. In contrast to the X variables, the Z variables enter the regression equation without group division.

The international factors are classified into intra- and inter- regional flows and relevant global commodity prices. As was noted in Chapter 2, the intra-regional flows are expected to have either positive or negative effects on intra-regional convergence depending on the theoretical model under consideration. By contrast, whether or not the inter-regional flows have any effects on the pattern of intra-regional convergence may depend on the income levels of external partners. Global commodity prices are also expected to have differentiated effects on country-level growth and, therefore, affect the pattern of intra-regional convergence directly. For example, given that high income countries are likely to consume more energy products, a change in the price of energy may have stronger growth effects (positive or negative) on the relatively high income countries. Global commodity prices are approximated by the energy commodity price index, the non-energy commodity price index, the price index for agricultural goods and the price index for raw materials.

5.3.2.2 Study Variables

The dependent variable (S_t) is measured as the standard deviation of regional income distribution. Regarding the domestic independent variables for both high and low income groups (X_{ht} and X_{lt}), following standard practice in empirical work, we use group average fixed capital formation rate (as a proxy for group physical capital growth), group average secondary school enrollment rate (as a proxy for the group rate of human capital accumulation), and group average rate of growth of the working age population (as a

proxy for group labour force growth). The international independent variables (Z_t) include the intra- and inter-regional flows of goods and services, foreign direct investment (FDI) and portfolio investment, movement of high technology goods and services (a proxy for technology flows), and the global prices of commodities. The intra-regional flows relative to GDP are measured by regional average for all countries and so are the ratios of hi-tech goods and services to intra-regional trade. The inter-regional flows are measured similarly.[95] The global commodity prices are measured by the energy commodity price index and non-energy commodity price index, and the price indices for agricultural goods and the price index for raw material. The list of variables is presented in Table A2 of the Appendix.

5.3.2.3 The Regression Technique

In order to apply the appropriate technique for regression analysis, we examined the stationary characteristics of the time series data in advance. We applied two types of stationary tests to the relevant series. The first was suggested by Kwiatkowski, Phillips, et al (1992) (henceforth the KPSS test) and the second is the Generalized Least Squares (GLS) version of the Dickey-Fuller test developed by Elliot, et al (1996) (henceforth the Augmented Dickey-Fuller or DF-GLS test) test. The former has a null of stationarity and is better than other tests at distinguishing between persistent (near unit root) but stationary processes and unit root processes (Lee and Schmidt, 1996). The DF-GLS test (which has a null of non-stationarity) has high power in small samples (Elliot, G. et al, 1996). In this

[95] Unlike intra-regional flows, inter-regional flows of imports and exports are not necessarily equal so they need to be measured separately.

paper, a time series is accepted as stationary if the KPSS accepts the null hypothesis (of stationarity) and the DF-GLS rejects the null of non-stationarity – meaning that the two tests are in agreement. KPSS and DFGLS tests reveal that except a few level variables, all the rest are non-stationary but their first differences remain stationary.[96] Thus, except for the I(0) right-hand-side variables, the dependent and the majority of right-hand-side variables are I(1). There was no I(2) variable (see Appendix A3 and A4).

There are various techniques for conducting the cointegration analysis, for example, the residual based approach (Vector Error Correction Model-VECM) proposed by Engle and Granger (1987), the maximum likelihood-based approach proposed by Johansen et al. (1990, 1992), and the Augmented Autoregressive Distributed Lag (ARDL) approach proposed and augmented by Pesaran et al. (1998, 2001). Of these, both the VECM and the maximum likelihood approaches require that variables in the system have the same order of integration. This requirement often causes difficulty when the system contains variables with different orders of integration as in this study. This makes the ARDL the most practical of the three approaches in this case. The immediate advantages of the ARDL method are twofold:

- It is applicable irrespective of whether the underlying regressors are purely I(0), purely I (1) or mixed so long as there is no I(2) variables involved;

[96] The stationary variables are secondary school enrollment rate in high-income country group, the working age population growth rate in the low income group and the inter-regional inflow of portfolio investment.

- It involves the estimation of a single equation to uncover both short run and long run coefficients, making it simple to implement and interpret.

Previously, the traditional ARDL model (see equation (7)) was generally not considered applicable in the presence of I (1) variables. Pesaran et al. (1998) re-examined the use of ARDL models for the analysis of cointegrating relations among I(1) variables. They provide evidence that the ARDL based estimators are consistent for both short run and long run coefficients after appropriate argumentation of the ARDL model. That is, by replacing level variables with their first differences and incorporating an error correction term (ECT_{t-1}) into a traditional ARDL model. Using the specification suggested by Pesaran et al. (2001), Equation (7) above becomes:

$$\Delta S_t = C + \sum_1^p \beta_i \Delta S_{t-i} + \sum_1^m \gamma_j \Delta X_{t-j} + \sum_1^n \delta_k \Delta Z_{t-k} + \theta_0 ECT_{t-1} + e_t \quad (9)$$

here, ECT_t, the error-correction term, is the OLS residuals series E_t from the long-run cointegrating regression:

$$S_t = -\frac{1}{\theta_0}(\theta_1 X_t + \theta_2 Z_t) + E_t \quad (10)$$

If we substitute $E_{t-1} = S_{t-1} + \frac{1}{\theta_0}(\theta_1 X_{t-1} + \theta_2 Z_{t-1})$ for ECT_{t-1} in equation (9) the augmented version of ARDL model for this study becomes:

$$\Delta S_t = C + \sum_1^p \beta_i \Delta S_{t-i} + \sum_1^m \gamma_j \Delta X_{t-j} + \sum_1^n \delta_k \Delta Z_{t-k} + \theta_0 S_{t-1} + \theta_1 X_{t-1} + \theta_2 Z_{t-1} + e_t \quad (11)$$

We can use equation (11) to estimate both the short run and long run effects that indicate the nature of the relationship between the standard deviation of regional income dispersion and each of its explanatory variables. The short run coefficients can be extracted

directly from equation (11), they are γ and δ, the coefficients of lag difference variables. Noting that at long-run equilibrium, $\Delta S = 0$, $\Delta X = \Delta Z = 0$, the long-run coefficients for X and Z can be constructed by $-(\theta_1/\theta_0)$, $-(\theta_2/\theta_0)$respectively.

In this study, we supply ΔS_t as an left-hand-side variable. The right-hand-side variables are the intercept C, S_{t-1}, X_{t-1} and Z_{t-1}, and a fixed number of lags of ΔS_{t-1}, ΔX_t and ΔZ_t. We determine the lag order by implementing a pre-estimation function for lag order selection (in Stata). These were determined by using four information criterion: the Final Prediction Error (FPE), the Akaike Information Criteria (AIC), the Hannan Quinn Informatin Criterion (HQIC) and the Schwarz-Bayesian Information Criterion (SBIC). These criteria are based on a high log-likelihood value, with a "penalty" for including more lags than necessary. The form of the penalty varies from one criterion to another. Each criterion starts with -2log(L), and then penalizes 2K, where L is the maximized value of the likelihood function for the model and K is the number of parameters in the model, therefore, the smaller the value of the information criterion the better and more “efficient” the model. The order selection criteria of FPE, AIC, HQIC and SBIC suggested that optimal lags should be p=4, m=n=1 (see table 5-1).

Table 5-1 Lag Length Selection for P (when m=n=1)[97]

Lag	FPE	AIC	HQIC	SBIC
|0|	.000061	-7.76738	-7.2762	-6.37415
|1|	.000042	-8.32452	-7.81799	-6.88775
|2|	.000051	-8.37947	-7.85759	-6.89917
|3|	.000075	-8.35139	-7.81416	-6.82755
|4|	.000013*	-10.7812*	-10.2287*	-9.21386*

Optimal options are marked by *

We then performed the Bounds Test, developed by Pesaran et al. (2001)[98], for the existence of a long run equilibrium relationship among the level variables in equation (11). As in a conventional F-test, we test the linear hypotheses H_0: $\theta_0=\theta_1=\theta_2=0$, against the alternative that H_0 is not true. A rejection of H_0 will suggest a long run relationship. However, there is a practical difficulty when the F-test is conducted for a combination of I(0) and I (1) variables. Since the distribution of the test statistic is totally non-standard, exact critical values for the F-test are not available for a mix of I(0) and I(1) variables. To solve this problem, Pesaran et al. (2001) computed lower and upper bounds on the critical values for the asymptotic distribution of the F-statistic. The lower bound is based on the assumption that all of the variables are I(0), and the upper bound is based on the assumption that all of the variables are I(1). In fact, the true (critical) value will lie somewhere in between these two values. Therefore, if the computed F-statistic falls below the lower bound, we cannot reject the null hypotheses and the Bonds Test concludes that

[97] Table 3-1 indicates when m and n equal to 1, the optimal lag for p equals to 4, which is the best combination, any other values of m and n could not provide us with better result.

[98] Pesaran et al (2001) developed the Bound Testing for the existence of a level relationship between a dependent variable and a set of regressors irrespective of whether those regressors are purely I(0), I(1) or mutually cointegrated.

no cointegrating relationship exists. If the F-statistic exceeds the upper bound, the Bounds Test concludes that a cointegrating relationship exists. Finally, if the F-statistic falls between the bounds, the test is inconclusive.[99]

For this study, we test the linear hypothesis that the coefficients of all level variables are jointly equal to zero after an appropriate version of the regression equation has been estimated.[100] The H_0 of joint zero coefficients was strongly rejected, which confirms the existence of a long run equilibrium relationship.[101]

The resulting equation was, nevertheless, quite large with several right-hand-side variables that might not belong in the equation – leading, potentially, to poor estimation results from over-parameterization. To develop a more parsimonious model, with better fit, we applied a general-to-specific approach as follows:

- First estimate a model with all potential explanatory variables;[102]
- Then eliminate the variable with highest p-value (that is also greater than 0.1);
- Refit the model. If the information criteria are smaller or unchanged repeat Step 2. If the information criteria increased, replace the variable and repeat Step 2 for the variable with the next highest p-value (that is also greater than 0.1).

[99] Since post-estimation linear hypothesis tests (in Stata) provide only chi2 statistics, we need to calculate the corresponding F statistics by dividing the degree of freedom of equation 11 and then apply upper and lower bounds to critical values of F tests.
[100] An appropriate version here means Equation 11 with optimal lags (based on the selection criteria).
[101] According to the linear hypothesis test output, chi2-statistic(15) equals to 88985.21 with zero probability which is equivalent to F-statistic(15) equals to 6356.09 with zero probability.
[102] In the case of variables that were very similar (such as some of the price indices) the best performing versions (based on both t-statistic and information criterion).

- Repeat the process until all p-values are less than 0.1 or the removal of any remaining variable (regardless of the size of its t-statistic and p-values) will cause the information criterion to increase (meaning that there is a net "information" loss for *excluding* any remaining variable).

The ARDL methodology requires the errors of regression equations must be serially independent and normally distributed.[103] After regression, we apply LM tests for residual autocorrelation and a series of normality tests (Jarque-Bera test, Skewness test and Kurtosis test) for residual normal distribution. The result of the LM test (see appendix table A5) shows that the null hypothesis of no autocorrelation cannot be rejected given the optimal lag(s) of (4, 1, 1). None of the normality tests reject the null hypothesis of normally distributed disturbances, which is desirable in appendix table A6.

For any models with autoregressive structure, we should check if the models are dynamically stable or not. More specifically, we need to make sure that all of the inverse roots of the characteristic equation associated with our model lie strictly inside the unit circle. The check of eigenvalue stability condition shows that all the eigenvalues lie inside the unit circle, which means the ARDL model satisfies the stability condition (see appendix table A7).

[103]This requirement may also be influential in the final choice of maximum lags for variables in the ARDL models because the common solution to the issue of autocorrelation is to add more lags.

5.3.3 Data and Sources

Since most potential determinants of income distribution are measured in US dollars, for consistency, there is a need to use US dollar as a measurement of per capita income. However, the measurement with US dollar is subject to the fluctuation of market exchange rates. Another drawback of the US dollar measurement is that market exchange rates are relevant only for internationally traded goods (Callen, 2007). Usually the prices of nontraded goods are higher in developed countries than emerging and developing countries. Therefore the US dollar measurement is likely to overestimate the welfare of high income countries and underestimate that of low income countries. The measurement of per capita income with international dollar is based on the exchange rates derived from Purchasing Power Parity (PPP). The PPP based exchange rates are good at catching up with the differences in the prices of non-traded goods across countries (Callen, 2007). In addition, using international dollar to measure per capita income can minimize misleading comparisons that may arise with the fluctuation of market exchange rates. However, the PPP based exchange rate has its own weaknesses. The major one is the inaccuracies related to its measurement. PPP rates are generated by the International Comparisons Program (ICP), based on a global survey of prices (Callen, 2007). Since survey data are available only in benchmark years, in the years between, the PPP rates have to be extrapolated by varies methodologies. Also, the ICP's survey does not cover all countries, which means that data for missing countries need to be estimated. Therefore the two forms of measurements are likely to complement each other since they have different types of weaknesses.

In this study, all income variables are measured as nominal GDP per capita using both international (PPP) and US dollars respectively. The data on income in international dollars are derived from the Penn World Table 8.0 (International Comparison of Prices Program, University of Pennsylvania). The data on income in US dollars are derived from United Nations Data (UN data 2014). The data for other variables come from a variety of datasets produced by the International Monetary Fund, the OECD, the World Bank and the United Nations. All of the potential dependent and independent variables and corresponding data source are listed in appendix A2.

5.4 RESULTS AND ANALYSIS

5.4.1 Convergence Test Results

5.4.1.1 Results from Log t Convergence Test

Using UN data (for US dollar per capita income) and Penn World Table (7.0) (for international dollar per capita income) we applied the log t convergence test to identify convergence clubs in East and South-East Asia during the post-Bretton Woods period (1970-2011).[104] The summarized test results are presented in table 5-2 and table 5-3 respectively.

[104] Please refer to Appendix table A9.1 and Appendix table A9.2 for log t convergence test outputs

Table 5-2 Log t Test for Convergence Club Identification (US Dollar)

Club 1	Club 2	Non-converging Unit(s)
Cambodia	China: Hong Kong SAR	Brunei Darussalam
China, People's Republic of	China: Macao SAR	Japan
Indonesia	Malaysia	Lao People's Dem. Republic
Mongolia	Philippines	Singapore
Myanmar	Taiwan	
South Korea		
Thailand		
Viet Nam		

Table 5-3 Log t Test for Convergence Club Identification (International Dollar)

Club 1	Club 2	Non-converging Unit(s)
Cambodia	China: Macao SAR	Brunei Darussalam
China, People's Republic of	Malaysia	Hong Kong
Indonesia	Mongolia	Japan
South Korea	Philippines	
Lao People's Dem. Republic	Singapore	
Thailand	Taiwan	
Viet Nam		

Regardless of the per capita income measure used, we do not find any evidence of overall regional convergence. There is however evidence of two convergence clubs and some non-converging (and possibly diverging) units. For both measures of per capita income, Club 1 includes the People's Republic of China, Republic of Korea, Cambodia, Indonesia, Thailand and Vietnam. Club 2 includes China Macao, Malaysia, the Philippines and Taiwan for both measures of per capita income. Mongolia is in different clubs depending on the income measure used and Lao PDR and Singapore are in one of the clubs or non-converging depending on the income measure used. Overall, the clubs are

remarkably consistent across the different measures of income but their constitution is surprising in some respects. While it is not surprising that the fast-growing China and recently-developed South Korea are in the same club, it is surprising that Cambodia with relatively unstable economic performance (overall) would belong to that club. It is probably due to the fact that despite sluggish growth in 1970s and 1980s, Cambodia's economic growth has held up very well since 1994. As we mentioned before, the log t convergence test is good at distinguishing countries with convergence tendency. Club 2 has a decidedly South-East-Asian flavour except for the presence of Taiwan. Taiwan is included in this club probably due to its strong economic relationship with most of the countries in South East Asia since 1987.[105]

It is likely Mongolia belongs in different clubs depending on the unit of measure used for per capita income because, as a fast-growing resource-rich economy, its purchasing-power-parity denominated rate of output growth is slower than its US dollar dominated rate of output growth. It is not clear, however, why Singapore, Hong Kong and Lao PDR are determined to be non-convergent when per capita income is measured in US dollars but belong to a convergence club when international dollars are used. Perhaps it reflects the fact that US dollar incomes exaggerate purchasing power – thereby leading to an exaggeration of these countries' growth trajectories. The persistent non-convergence status of Brunei is, however, not surprising. As an oil-rich economy, its fortunes are more closely related to that of the price of oil than to any regional factors.

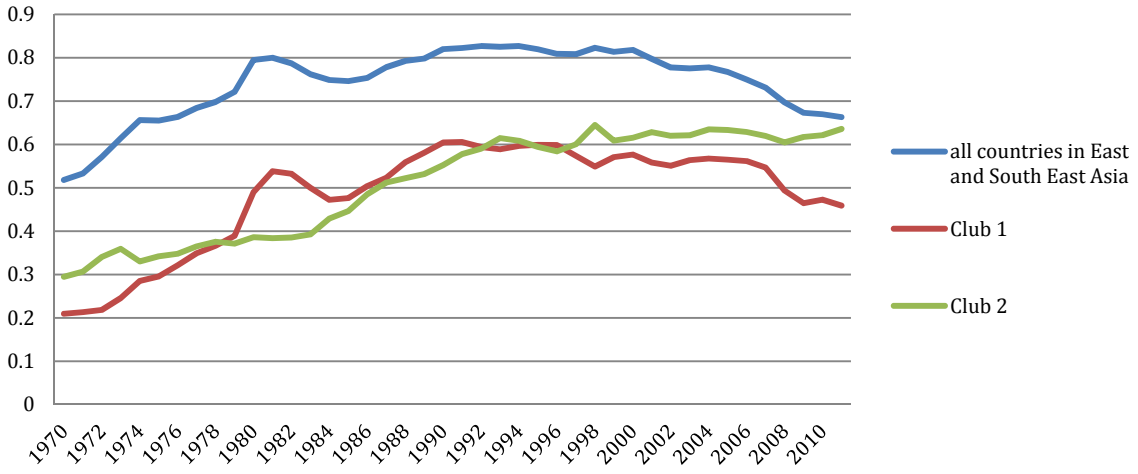
[105]Samuel C Y KU, East Asian Policy, 2009

The status of Japan is of particular interest. From the tests, Japan does not belong to any convergence club regardless of the unit of measure used for per capita income. In terms of per capita income, Japan is no longer an outlier in East Asia since South Korea's income, especially when measured in international dollars, is now close to that of Japan. However, Japan has experienced much lower growth rates than the rest of East and South East Asia since the early 1990s and this may explain its non-convergent status.

5.4.1.2 Sigma Convergence Test Results

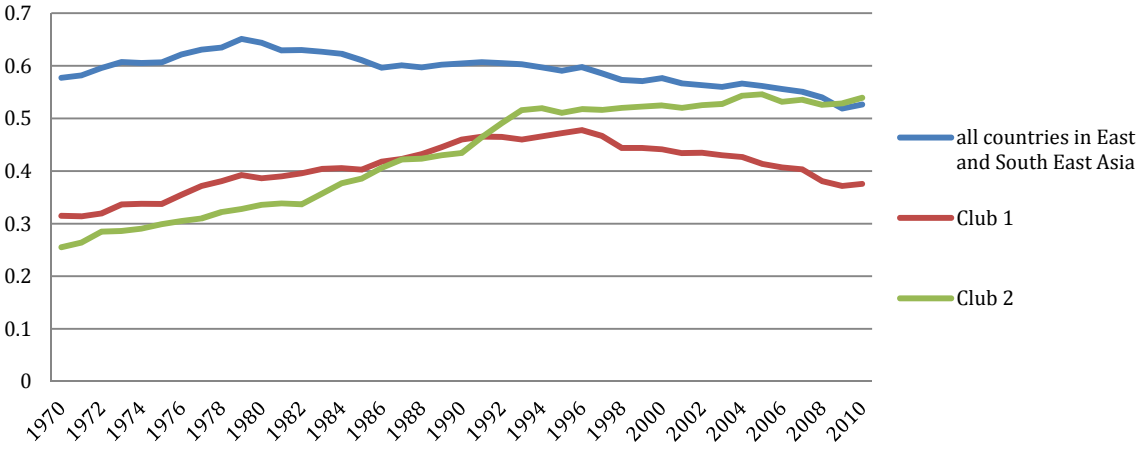
Per capita income has been measured by international and US dollars. The corresponding results from sigma convergence tests are slightly different and presented in figure 5-2 and figure 5-3 respectively.

Figure 5-2
standard deviation of per capita GDP (in US dollars) across coutries in East and South-East Asia



Data source: UN data 2014 (GDP Per Capita, at current prices in US Dollars)

Figure 5-3
standard deviation of per capita GDP (in Internatioinal dollars) across countries in East and South-East Asia



Data source: Penn World table 7.0 (PPP Converted GDP Per Capita, at current prices in International Dollars)

Both Figure 5-2 and figure 5-3 indicate that, since 1970, the region of East and South-East Asia has experienced patterns of both divergence and convergence regardless of whether the measure of per capita income is international (PPP) dollars or US dollars. Figure 5-2 shows that per capita incomes (measured in US dollars) across East and South-East Asian countries were diverging in the 1970s. This period of divergence was reversed, beginning in 1980. After a short period of convergence (from 1981 to 1984), persistent divergence dominated the period from 1985 to 1992. The period from 1992 to 1998 was relatively stable, with no obvious divergence or convergence. The latter part of the study period (1998-2011) was marked by convergence. Figure 5-3 presents a similar trend but with less fluctuation. The per capita incomes (measured in international dollars) across East and South-East Asian countries were diverging in the early 1970s. After 1978, a mild and nearly monotonic convergence trend dominated the rest of the whole period. From figure 5-2 and figure 5-3, we note that one of the major turning points in the period of study occurred around 1978 to 1980, which can probably be attributed to the

implementation of the "open door" policy (1978) in China. Due to the size of the Chinese economy, its "open door" policy would have increased the entire region's flows of trade, capital, labor, and technology. These intra-regional flows might, in turn, have affected the pattern of intra-regional convergence.

From figure 5-2 and figure 5-3, we do not see consistent sigma convergence trends for any of the log t convergence clubs for the whole time period. However, the result from sigma convergence test is not wholly contradictory to that of log t convergence test.[106] If we closely look at figure 5-2 and figure 5-3, we will find the results from sigma convergence tests are, at least, partially consistent with the outputs of log t convergence tests. Actually figure 5-2 and figure 5-3 present very similar patterns of intra-club convergence/divergence. For both clubs, the pattern of intra-club divergence dominated the period from 1970 to 1992. Since then club 1 has experienced a persistent intra-club convergence while club 2 stopped diverging and has been in a neutral state.[107] For the last two decades, club 1 has exhibited a consistent convergence trend, and although club 2 did not show any convergence trends, the divergence within this club appears to have been halted.

[106] The sigma convergence test provides evidence of income level convergence experienced over the period measured whereas the log t convergence test attempts to identify convergence tendencies. Also, the log t convergence test allows for different transitional paths towards convergence and discards a fraction of early data. Both of these factors increase the likelihood of finding convergence relative to the sigma test.

[107] Here it refers to the case neither converge nor divergence

5.4.2 Possible Determinants of Intra-Regional Convergence Trends

The ARDL regression outputs presented in Appendix Table A8 reveal a number of long-run as well as short-run effects on the pattern of intra-regional convergence. Based on the regression result, the long run and short run coefficients are extracted and presented in table 5-4-1 and table 5-4-2 respectively. Notably, none of the global commodity price indices proved to be significant or survived the general-to-specific estimation procedure.

Table 5-4-1 Long Run Coefficients

Independent Variable Name	**Coefficient**
Constant term	-0.1853
Average fixed capital formation high income	0.0002
Average fixed capital formation low income	-0.0012
Average secondary education enrolment rate high income	0.0001
Average secondary education enrolment rate low income	-0.0017
Average working age population growth rate high income	-0.0018
Average working age population growth rate low income	-0.0004
intra-regional trade as percent GDP	-0.0088
intra-regional high-tech trade as percent all commodity	-0.0000
inter-regional export as percent GDP	0.0203
inter-regional import as percent GDP	-0.0043
inter-regional FDI inflow as percent GDP	-0.0027
inter-regional portfolio inflow as percent GDP	0.0013
inter-regional high-tech export as percent all commodity	0.0002
inter-regional high-tech import as percent all commodity	-0.0001

Table 5-4-2 Short Run Coefficients

Independent Variable Name	Coefficient
Average fixed capital formation high income	-0.0033
Average fixed capital formation low income	-0.0045
Average secondary education enrolment rate high income	0.0003
Average secondary education enrolment rate low income	-0.0011
Average working age population growth rate high income	-0.0030
Average working age population growth rate low income	-0.0473
intra-regional trade as percent GDP	-0.0234
intra-regional FDI inflow as percent GDP	0.0026
intra-regional portfolio inflow as percent GDP	-0.0003
intra-regional high-tech trade as percent all commodity	-0.0002
inter-regional export as percent GDP	0.0110
inter-regional import as percent GDP	0.0019
inter-regional FDI inflow as percent GDP	-0.0022
inter-regional portfolio inflow as percent GDP	-0.0012
inter-regional high-tech export as percent all commodity	-0.0001
inter-regional high-tech import as percent all commodity	-0.0002

5.4.2.1 Long Run Effects on Intra-regional Convergence

5.4.2.1.1 Determinants of Output

As expected, determinants of growth for the high income (country) group have divergent effects while the determinants for the low income group have convergent effects.[108] However, there is one exception, a higher working age population growth rate for the high-income group tends to reduce (rather than expand) the degree of dispersion of

[108] A negative coefficient indicates convergent effects, because the standard deviation is getting smaller, while a positive coefficient indicates divergent effects because the standard deviation is getting larger.

intra-regional incomes. We suspect that this measure of working age population is not a very good proxy for the rate of growth in employment. Since the labour force participation rate in the richer countries, especially in Japan and Hong Kong, was falling through most of that period, the growth of working age population reflects the growth of population much more than the growth of employment. [109]

5.4.2.1.2 Trade Flows

The regression results indicate that intra- and inter-regional trade flows do not have quite the same effect on the intra-regional distribution of incomes. Increased intra-regional trade, in general, tends to reduce the dispersion of regional incomes.[110] The same is true of inter-regional imports but inter-regional exports tend to increase the dispersion of regional incomes. The effects of intra-regional trade and inter-regional imports are in line with the predictions of neoclassical trade models. It is likely that the large trade in unfinished goods generated by regional supply-chain-based production has much to do with that effect. However, the divergent effect of exports would seem to be better explained by structuralist models (in particular, the Wallerstein (1974) and Botta (2009) models). It is likely that the divergent effects of export trade comes from the fact that successfully industrializing countries are able to move up the value chain and/or increase export volumes sufficiently to generate rapid growth (and likely convergence to advanced economies) but in doing so they leave the less successful countries behind. This may, in fact, be a large part of the

[109] The labour force participation rates have declined from 64% to 59% in Japan and Hong Kong since 1991 (data from WDI World Bank).

[110] Intra-regional exports and imports cannot be differentiated because they are, in effect, one and the same because the exports from country A to country B are equal to the imports of country B from country A.

explanation for the club convergence phenomenon noted earlier. The (unweighted) average annual rate of growth in the value of merchandise exports of core Club 1 countries (Cambodia, China, Indonesia, South Korea, Thailand and Vietnam) has been twice that of the core Club 2 countries (Macao, Malaysia, Philippines) since 1970.

5.4.2.1.3 Financial Flows

Intra-regional flows of capital (both FDI and portfolio) were found to have no statistically significant effect on the dispersion of regional incomes. This is surprising, given the importance of Japan as a source of foreign direct investment in the region. It would appear that any positive output growth effect from these flows is unbiased in its distribution. By contrast, inter-regional FDI does promote convergence. This is supportive of the neoclassical view that FDI-based investments promotes growth in lower-income countries by transferring technological, managerial and institutional benefits in addition to the capital infusion. However, the opposite would appear to be the case for inter-regional portfolio investment – it is associated with increased dispersion of regional incomes. Given the nature of portfolio investment, this is not a particularly surprising result. It is well known that financial sector development must reach a threshold (in both size and sophistication) before substantial levels of portfolio investment are attracted into the economy. This would mean that it is only higher-income economies that can benefit from this type of investment flow – thus enhancing their growth relative to lower-income economies. This is very much akin to the threshold effect noted with respect to technology transfers in the endogenous growth model developed by Benhabib and Spiegel (1994). The threshold effect is also shown to apply to the case of FDI inflows by Borensztein, Gregorio &

Lee (1998), and in this case, it is financial sector development, rather than human capital development, that determines the threshold. As such, the impact of inter-regional portfolio flows is much similar to the presumptions of Wallerstein's (1974) model – in its suggestion that capital flow from the core economies would benefit the newly and semi-industrialized (semi-periphery) countries and not lower-income (periphery) countries.[111]

5.4.2.1.4 Technology Transfer

In the absence of a direct measure of technology transfer, we use trade in high technology goods as a proxy for technology flows.[112] The results from Table 5-4 indicate that growth in intra-regional trade in high-technology goods tends to reduce the dispersion of intra-regional incomes. However, though inter-regional high-technology imports enhance convergence, inter-regional high-technology exports have the opposite impact (with a significant and large coefficient). This pattern is best explained by endogenous growth models that suggest that intra-regional transfer of technology is likely to be more successful because of relatively narrower technology gaps at the intra-regional level. These models also suggest that inter-regional technology flows will have differentiated impact depending on countries' ability to absorb technology. In the context of these models, the dispersion-reducing impact of high-technology imports can be seen as the greater growth impact of more passive technology spillovers for poorer countries while the opposite

[111] The assumption that inter-regional capital flows come necessarily from the core economies is not a strong one since the economies of Western Europe and North America have been the source of an overwhelming proportion of portfolio flows.

[112] For the same reason mentioned in chapter 4 (4.2.1.4), we choose trade in high technology goods as a proxy indicator of technology transfer.

effects of exports of high-technology goods indicate the strong bias of active technology transfer in favour of better human capital endowed countries (as well as those with smaller technology gaps) and against the poorest countries.

5.4.2.2 Short Run Effects on Intra-regional convergence

The short run effects of domestic factors are similar to corresponding long run effects. The only difference is that the short-run effect of increased capital formation in the high-income group of countries favours intra-regional convergence (as opposed to the divergent effect of long-run capital formation). This may simply be an indication that the gestation period for investment in the high-income country group is longer than it is in the low-income country group.

In contrast to the long run, the coefficients for all the short-run intra-regional flows are significant. The results show that in the short run, intra-regional trade has the same (dispersion reducing) effects that it has in the long run. Intra-regional FDI flows are associated with increased income dispersion in the short run but portfolio investment has the opposite effect. This is not contradictory if it is understood that this relationship is not necessarily causal. If intra-regional FDI flows come mostly from the more successful to the weaker economies, with a presumed long gestation period (meaning no initial growth impact), then it would appear to be biased in favour of high growth in the richer economies in the short run – hence divergence. In the case of portfolio flows, it is worth noting, first, that most intra-regional flows will be between higher-income countries and, second, that three of these economies (Hong Kong, Macao and Singapore) are financial centers. If slow growth in the higher income countries (which reduces income dispersion) is associated

with capital flight to the financial centers(for "haven seeking"), then a negative short-run relationship between portfolio flows and income dispersion is to be expected. Intra-regional trade in high-technology goods suggest the same impact in the short-run as the long-run.

Most of inter-regional flows also do not indicate the same impact for the short and long-run. Again, if these relationships are not seen as necessarily causal in the short-run, these differences are not difficult to explain. The positive short-run coefficients for inter-regional exports and imports (implying increased income dispersion for both) can be understood in the context of higher short-run import and export propensities in the higher-income countries of the region.[113] The negative short-run coefficients for inter-regional portfolio flows (implying reduced dispersion) is likely, similar to intra-regional flows, an indication of the impact of the wealthy financial centers of the region. These financial centers tend to have large negative inflows (large net outflows) that move largely in opposition to inter-regional inflows into the rest of the region in the short-term. Hence, "haven seeking" from outside the region might be highly correlated with poor performances in the region because of the presence of the financial centers – hence the negative correlation with dispersion. The negative short-run relationship between the export of high-technology goods and income dispersion (compared to the positive long-run relationship) is likely derived from the fact that the most successful exporters of high-technology goods (China, Malaysia, Thailand) began in the middle or bottom of the income

[113] Some of this may come from the advantage of better logistics networks and non-binding foreign exchange constraints.

distribution (thus helping to reduce dispersion initially) but moved very rapidly to the upper end (implying a different long-term impact).

5.5 CONCLUSION

In recent years, empirical studies on the pattern of intra-regional convergence have expanded significantly and many of them focus on the impact of regional political and economic agreements. The region of East and South-East Asia has been experiencing significant levels of economic regionalization over the past two decades.[114] However, the engines of economic regionalization in East and South-East Asia come, at least in part, from the explosive growth of regional supply chains, which are quite different from formal economic or political arrangements such as multi-country free trade agreements, common markets etc. In this case, the impacts of economic regionalization on the degree of intra-regional income convergence/divergence will largely depend on the effects of increased intra-regional trade, investment and technology flows (in addition to any effects of inter-regional flows). Yet, the specific effects of intra and inter-regional flows on the pattern of intra-regional income convergence have remained largely unexplored. We therefore sought to determine whether these flows might be at least partially responsible for the pattern of intra-regional income convergence in East and South-East Asia, and in which direction.

In this study, we first examined the pattern of income convergence in East and South-East Asia during the post-Bretton Woods period, and then analyzed its potential determinants. Specifically using time series data, we applied sigma and Log t convergence

[114] Economic regionalization refers to the increase of economic interaction within a region

tests for the pattern of convergence and autoregressive distributed lagged (ARDL) models to analyze the relationship between regional income dispersion and related factors. In particular, we investigated the effects of intra and inter-regional flows of trade, capital and technology for the short run and long run respectively. Our main findings are summarized in the following paragraphs.

Regardless of whether per capita income is measured in US or international dollars, the log t convergence tests identified the existence of two convergence clubs instead of overall convergence trends in East and South-East Asia. Club 1 includes the People's Republic of China, Republic of Korea, Cambodia, Indonesia, Thailand and Vietnam regardless of the per capita income measure used. Club 2 includes the Macao, Malaysia, the Philippines and Taiwan regardless of the per capita income measure used. Both clubs have experienced rapid economic growth since 1970. On average, club 1 grew faster than club 2.[115]

The sigma convergence tests suggested recent income convergence in East and South-East Asia but no consistent convergence over the whole period of study. They also did not indicate persistent convergence trends for either of the convergence clubs. In fact, they suggested only recent convergence trend for Club 1 and current stable period (no trend) for Club 2.

Our regression analysis indicates both domestic and international factors are related to the pattern of intra-regional income convergence. As expected, most of domestic

[115] From 1970 to 2013, the average growth rate of club 1 was above 7 % while that of club 2 was around 6 %.

factors related to economic growth for the high income (country) group have divergent effects on the intra-regional distribution of income while those for the low income group have convergent effects. These observations applied to both the short run and long run.

International factors consist of intra and inter-regional flows of trade, capital, and technology and related global price indices. Among intra-regional flows, intra-regional trade and intra-regional trade in high technology products have convergence effects on regional income dispersion for both the short run and long run, which is in line with the predictions of related neoclassical models. On the other hand, intra-regional financial flows (both FDI and Portfolio) do not have any significant long run effects on the pattern of intra-regional convergence. It is likely that these financial flows have had comparable effects across all economies due to the characteristics of supply-chain-based production in East and South-East Asia.

With respect to inter-regional flows, inter-regional import and export have quite different effects on intra-regional income dispersion. Inter-regional exports increase the dispersion of regional income for both the short run and long run. Although inter-regional imports have divergent effects for the short run, in the long run they are associated with intra-regional income convergence. Inter-regional flows of import and export in high technology products have similar effects (on intra-regional income dispersion) to the flows of trade. Inter-regional FDI flows have significant long run convergence effects on intra-regional income dispersion. However inter-regional portfolio flows have long run divergence effects. This likely derives from the fact that portfolio flows are advantageous only to the higher income countries in the region who have reached a certain level of

financial development – leading to the promotion of growth only at the upper end of the distribution of income.

Energy and non-energy commodity price indices are irrelevant to regional income convergence. This is probably because East and South-East Asia have diversified import and export profiles that mute any commodity price effects.

APPENDIX

Table A1: Country Sample

East and South-East Asian Countries Included in the Sample
1. Brunei Darussalam
2. Cambodia
3. China, People's Republic of
4. China: Hong Kong SAR
5. China: Macao SAR
6. Indonesia
7. Japan
8. Lao People's Dem. Republic
9. Malaysia
10. Mongolia
11. Myanmar
12. Philippines
13. Singapore
14. South Korea
15. Taiwan
16. Thailand
17. Viet Nam

Table A2: Variable List and Data Source

Potential Dependent and Independent Variables	Data Source
Coefficient of variation of intra-regional per capita GDP distribution (GDP measured in US dollars)	United Nation Statistic Division, UN data 2014
Coefficient of variation of intra-regional per capita GDP distribution (GDP measured in international dollars)	Penn World Table 7.0, University of Pennsylvania
Gross fixed capital formation (% GDP)_High income	World Development Indicator, World Bank
Gross fixed capital formation (% GDP)_Low income	World Development Indicator, World Bank
Secondary school enrollment rate _High income	World Development Indicator, World Bank
Secondary school enrollment rate _Low income	World Development Indicator, World Bank
Growth rate of working age population _High income	World Development Indicator, World Bank
Growth rate of working age population _Low income	World Development Indicator, World Bank
World export % gdp	UN Comtrade Database
Inter-regional export % gdp	UN Comtrade Database
World import % gdp	UN Comtrade Database
Inter-regional import % gdp	UN Comtrade Database
Intra-regional trade % gdp	UN Comtrade Database
World FDI inflow % gdp	OECD Stat
Inter-regional FDI inflow % gdp	OECD Stat
Intra-regional FDI inflow % gdp	OECD Stat
World portfolio inflow % gdp	OECD Stat
Inter–regional portfolio inflow % gdp	OECD Stat
Intra–regional portfolio inflow % gdp	OECD Stat
World import hi_tech % all commodities	UN Comtrade Database
Inter-regional import hi_tech % all commodities	UN Comtrade Database
World export hi_tech % all commodities	UN Comtrade Database
Inter-regional export hi_tech % all commodities	UN Comtrade Database
World trade hi_tech % all commodities	UN Comtrade Database
Inter-regional trade hi_tech % all commodities	UN Comtrade Database
Energy price index (2005=100)	IMF Primary Commodity Prices
Crude oil price index (2005=100)	IMF Primary Commodity Prices
Natural gas price index (2005=100)	IMF Primary Commodity Prices
Non-energy commodity price index (2005=100)	IMF Primary Commodity Prices
Agricultural commodity price index (2005=100)	IMF Primary Commodity Prices
Raw materials price index (2005=100)	IMF Primary Commodity Prices

Table A3: Unit Root Tests for the Level of Dependent and Potential Explanatory Variables

Variable Name (in levels)	KPSS null of stationary		Augmented DF null of unit root(s)	
	level	trend	level	trend
Coefficient of variation of intra-regional per capita GDP distribution (US dollars)	.878**	.349**	-0.926	-0.936
Gross fixed capital formation (% GDP)_High income	.856**	.211*	-2.098*	-0.896
Gross fixed capital formation (% GDP)_Low income	.0926	.0926	-1.401	-2.566
Secondary school enrollment rate X10_High income	.326	.0762	-3.646**	-3.554**
Secondary school enrollment rate X10_Low income	.27	.226**	-1.471	-1.748
Growth rate of working age population x10_High income	1.02**	.274**	0.284	-1.546
Growth rate of working age population x10_Low income	.453	.109	-2.168*	-3.325*
Intra-regional trade % gdp	1.44**	.301**	0.713	-1.597
Inter-regional export % gdp	1.23**	.188*	-0.379	-1.953
Inter-regional import % gdp	1.02**	.244**	0.026	-2.130
Inter-regional fdi inflow % gdp x10	1.29**	.0994	-1.175	-1.029
Intra-regional fdi inflow % gdp x10	1.43**	.233**	-0.286	-1.826
Inter –regional portfolio % gdp x10	.108	.106	-2.833**	-2.967
Intra-regional portfolio % gdp x10	.765**	.105	-1.972*	-2.298
Hi-tech %all commodity intra-regional export x10	1.47**	.215*	-0.395	-1.337
Hi-tech %all commodity inter-regional export x10	1.12**	.109	-1.804	-2.362
Energy price index	.934**	.266**	-0.016	-1.864
Non-energy price index	.836**	.202*	1.334	-1.238

* rejected at 5%
** rejected at 1%

Table A4: Unit Root Tests for the First Difference of Dependent and Potential Explanatory Variables

Variable Name (in first difference)	KPSS null of stationary		Augmented DF null of unit root(s)	
	level	trend	level	trend
Coefficient of variation of intra-regional per capita GDP distribution (US dollars)	.66*	.0328	-3.521**	-5.443**
Gross fixed capital formation (% GDP)_High income	.17	.0463	-2.568*	-3.206*
Gross fixed capital formation (% GDP)_Low income	.189	.053	-4.223**	-4.569**
Secondary school enrollment rate X10_High income	.0537	.0527	-6.021**	-7.005**
Secondary school enrollment rate X10_Low income	.0943	.0419	-1.235*	-4.286**
Growth rate of working age population x10_High income	.0926	.0828	-4.332**	-3.952**
Growth rate of working age population x10_Low income	.255	.122	-2.525*	-2.782
Intra-regional trade % gdp	.127	.0511	-0.545*	-3.974**
Inter-regional export % gdp	.0703	.0712	-3.428**	-3.447*
Inter-regional import % gdp	.0946	.0552	-4.177**	-4.626**
Inter-regional fdi inflow % gdp x10	.0452	.0423	-8.050**	-8.517**
Intra-regional fdi inflow % gdp x10	.0953	.0759	-4.563**	-4.708**
Inter –regional portfolio % gdp x10	.0485	.0417	-3.474**	-3.493*
Intra-regional portfolio % gdp x10	.0565	.0499	-5.722**	-5.664**
Hi-tech %all commodity intra-regional export x10	.137	.12	-2.907**	-3.027*
Hi-tech %all commodity inter-regional export x10	.0609	.0568	-6.350**	-6.378**
Energy price index	.339	.141	-2.339*	-4.885*
Non-energy price index	.273	.15	-3.719**	-4.14**

* rejected at 5%
** rejected at 1%

Table A5: Lagrange-Multiplier Test for Auto Correlation

Test Hypotheses	No auto correlation at lag order:		
Test Output	**chi2**	**df**	**Prob>chi2**
lag (1)	0.4013	1	0.52641
lag (2)	0.0967	1	0.75578
lag (3)	0.9498	1	0.32978
lag (4)	0.0969	1	0.75554

Table A6: Tests for Normally Distributed Disturbances

Test Hypotheses	disturbances are normally distributed		
Test Output	**chi2**	**df**	**Prob>chi2**
Jarque-Beratest			
D_UNVNF	2.283	1	0.31937
ALL	2.283	1	0.31937
Skewness			
D_UNVNF	1.643	1	0.19996
ALL	1.643	1	0.19996
Kurtosis			
D_UNVNF	0.640	1	0.42365
ALL	0.640	1	0.42365

Table A7: Eigen Value Stability Condition Test

Eigen Value		**Modulus**
.5255356	+.4475041i	.690252
.5255356	-.4475041i	.690252
-.3771403	+.4248326i	.568082
-.3771403	-.4248326i	.568082

Table A8: ARDL Regression Outputs EA

Sample: 1975-2011 No. of obs = 37
Log likelihood=286.5888 AIC=-13.54534
FPE=8.00e-07 HQIC=-12.99277
Det (Sigma_ml)=1.10e-08 SBIC=-11.97796

Equation	RMSE	R-sq	chi2	P>chi2
D_S	.000637	0.9997	126092.5	0.0000
Var.	**Coef.**	**Std.Err.**	**z**	**P>|z|**
S				
L1D.	-2.048815	.0267782	-76.51	0.000
L2D.	-2.050860	.0318364	-64.42	0.000
L3D.	-2.033193	.0235813	-86.22	0.000
L4D.	-1.982370	.0275109	-72.06	0.000
GFCFH				
LD.	-.0032612	.0001731	-18.84	0.017
GFCFL				
LD.	-.0044545	.0000453	-98.44	0.000
CSE10H				
LD.	.0002782	.0000102	27.28	0.000
CSE10L				
LD.	-.0011285	.0000156	-72.44	0.000
GWP10H				
LD.	-.0029912	.0000934	-32.03	0.056
GWP10L				
LD.	-.0472835	.0005160	-91.52	0.000
TERAPG				
LD.	-.0233501	.0003632	-64.30	0.000
TEERPG				
LD.	.011042	.0001011	109.22	0.000
TIERPG				
LD.	.0018512	.0003745	4.94	0.000
FERPF10				
LD.	-.0022201	.000033	-67.27	0.000
FRAPF10				
LD.	.0025979	.0000328	79.09	0.000
PERPF10				
LD.	-.0012109	.000059	-20.53	0.000
PRAPF10				
LD.	-.0002775	2.68e-06	-103.50	0.000
HTRAPA10				
LD.	-.0002275	5.47e-06	-41.58	0.000
HTIERPA10				
LD.	-.0001999	2.46e-06	-81.36	0.000
HTEERPA10				
LD.	-.0000641	8.32e-07	-76.99	0.000
S				
L1.	-1.389971	.0269412	-51.59	0.000
GFCFH				
L1.	.0002492	.0001168	2.13	0.033
GFCFL				
L1.	-.0016083	.000056	-28.70	0.000
CSE10H				
L1.	.0001036	.0000153	6.78	0.000
CSE10L				
L1.	-.0023134	.0000293	-79.03	0.000
GWP10H				
L1.	-.0025231	.0000895	-28.19	0.000
GWP10L				
L1.	-.0005957	.0001286	-4.63	0.000

TERAPG				
L1.	-.0122421	.0004771	-25.66	0.000
TEERPG				
L1.	.0282265	.0002066	136.62	0.000
TIERPG				
L1.	-.0059727	.0004862	-12.29	0.000
FERPF10				
L1.	-.0037358	.0000571	-65.40	0.000
PERPF10				
L1.	.0017683	.0000909	19.44	0.000
HTRAPA10				
L1.	-.0000139	6.31e-06	-2.20	0.028
HTIERPA10				
L1.	.0002844	3.77e-06	75.44	0.000
HTEERPA10				
L1.	-.0001959	1.69e-06	-115.80	0.006
Cons	-.1853175	.0043026	-43.07	0.000

Table A9.1: Log t Convergence Test Outputs (US dollar)

Field	Value	Max	Min
Club members	17x2 double	17	0
Clubs	2	2	2
Divergence Unit	[1;7;8;13]	13	1
Pure convergence	0	0	0
Club1	**Club2**	**Divergent Unit**	**Pure convergent**
2	4	1	0
3	5	7	
6	9	8	
10	12	13	
11	15		
14	0		
16	0		
17	0		
0	0		
0	0		
0	0		
0	0		
0	0		
0	0		
0	0		
0	0		
0	0		

1. Brunei Darussalam 2. Cambodia 3. China, People's Republic of 4. China: Hong Kong 5. China: Macao 6. Indonesia 7. Japan 8. Lao People's Dem. Republic 9. Malaysia 10. Mongolia 11. Myanmar 12. Philippines 13. Singapore 14. South Korea 15.Taiwan 16.Thailand 17.Viet Nam

Table A9.2: Log t Convergence Test Outputs (International dollar)

Field	Value	Max	Min
Club members	17x2 double	17	0
Clubs	2	2	2
Divergence Unit	[1;4;7]	7	1
Pure convergence	0	0	0
Club1	**Club2**	**Divergent Unit**	**Pure convergent**
2	5	1	0
3	9	4	
6	10	7	
8	12		
14	13		
15	15		
17	0		
0	0		
0	0		
0	0		
0	0		
0	0		
0	0		
0	0		
0	0		
0	0		
0	0		

1. Brunei Darussalam 2. Cambodia 3. China, People's Republic of 4. China: Hong Kong 5. China: Macao 6. Indonesia 7. Japan 8. Lao People's Dem. Republic 9. Malaysia 10. Mongolia 11. Myanmar 12. Philippines 13. Singapore 14. South Korea 15.Taiwan 16.Thailand 17.Viet Nam

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CHAPTER 6: SUMMARY AND CONCLUSIONS

This dissertation sought to empirically analyze the impact of economic globalization on regional income convergence. The dissertation consists of three empirical essays. The first essay answered two questions. First, to what extent have peripheral world regions been converging (or diverging) to (or from) the core world region since 1970? And second, what are the effects of globalizing flows on the tendencies towards convergence or divergence? The second essay examined the patterns of intra-regional income convergence (or divergence) in Latin America and the Caribbean and assessed the effects of inter- and intra-regional flows on the inclination to converge to or diverge from the regional income average. In the third and final essay, we investigated the patterns of intra-regional income convergence (or divergence) in East and South-East Asia and, as in the Case of Latin America and the Caribbean, analyzed the effects of globalizing flows (both inter- and intra-regional flows) on the pattern of income convergence (or divergence) among countries in East and South-East Asia.

In the first essay, the world was divided into ten world regions: Central Asia, East Asia, Eastern Europe, Latin America and the Caribbean, Middle East and North Africa, North America, South Asia, Sub-Saharan Africa, the Pacific Region and Western Europe. Among them, North America was defined as the core region and the remaining regions as peripheral regions. The results of sigma convergence tests revealed that, in general, the ten world regions have experienced both convergence and divergence for the period of study. Specifically the level of income dispersion was falling rapidly in the first half of the 1970s but was mostly rising from the time of the first oil crisis to the end of the 1990s. The first

decade of the 21st century saw another rapid decline in the dispersion of regional incomes but that period of convergence has been halted by the Global Financial and Economic Crisis.

In terms of the performance of individual peripheral regions relative to the core, Pair-Wise convergence tests (for stochastic convergence) indicated most regions do not show a consistent pattern of convergence to, or divergence from, the core regions. For instance, Sub Saharan Africa has experienced the longest periods of divergence (through most of the 1970s, 80s and 90s) but it also experienced a strong period of convergence in the 2000s. East Asia experienced strong convergence through the 1970s and 1980s but that was interrupted by the Asian financial crisis. Central Asia and Eastern Europe, not surprisingly, demonstrated strong divergence from the core in the 1990s (after the demise of the Soviet Union) but have demonstrated equally strong catching-up since then. Although tests of pair-wise convergence indicate that no region demonstrated stochastic *convergence in output* to the core region, according to the Bernard and Durlauf (1995) definition, all regions demonstrated a *common trend in output* with the core. However, the strength of that common trend varied significantly across peripheral regions. The Pacifica Region (Australia, Fiji, New Zealand and Papua New Guinea) and Western Europe had common trends that were near unity – indicating near convergence with the core. Compared to the two advanced regions, four middle-income regions (Central Asia, Eastern Europe, Latin America & Caribbean and Middle East & North Africa) had relatively smaller common trend coefficients – suggesting their semi-periphery status. Three regions (East Asia, South Asia and Sub-Saharan Africa) had the weakest common trend coefficients that suggest the outer periphery status of these regions.

A test of overall and club convergence (the log t test) indicate that there was no evidence of overall convergence among all world regions. However, across the two measures of output (international dollars and US dollars) two convergence clubs could be identified. The first club always included Latin America & Caribbean and the Middle East & North Africa and the members of the second club were North America and the Pacific Region. The first club is clearly a club of semi-periphery, middle-income regions and the second is clearly a club of core, high-income, regions.

With regard to the impact of globalization, we used panel data regression analysis to determine whether globalizing flows could be directly related to changes in the core-periphery income gaps and found the following results. Regardless of the measure of output used, we found that none of the globalizing variables (trade, finance or technology flows) had any strong statistical association with changes in regional output differentials. With respect to global commodity price indices, an increase in the price of fuel or non-fuel commodities appears to have a stronger deleterious effect on the core regions than on peripheral regions, thus providing an impetus for inter-regional convergence. The most powerful influence on income gaps, and therefore on convergence, was found to be the investment gap (between the core and periphery).

In the second essay, we first examined the pattern of income convergence in Latin America and the Caribbean during the post-Bretton Woods period, and then analyzed its potential determinants. Specifically, using time series data, we applied sigma and *log t* convergence tests to assess the pattern of convergence and used autoregressive distributed lagged (ARDL) models to analyze the relationship between regional income dispersion and

related factors. In particular, we investigated the effects of intra and inter-regional flows of trade, capital and technology for the short run and the long run. Our main findings are summarized as follows: Using international dollars as the standard of measure for nominal per capita GDP, the *log t* convergence test generated three clubs (Club 1 with 12 countries; club 2 with 10 countries and club 3 with only two countries). On the other hand, using US dollars as the standard of measure for nominal per capita GDP, the *log t* test revealed an overall convergence trend for all of the 26 Latin American countries. Regardless of the measurements used for per capita income, the sigma convergence tests indicated no obvious trend of convergence or divergence for the region and each of the three convergence clubs (identified by the *log t* test) over the period of study.

Based on our regression analysis, both domestic and international factors are related to the pattern of intra-regional income convergence in Latin America and the Caribbean. As expected, most of the domestic factors (determinants of growth) for the high income country group have divergent effects on the intra-regional distribution of income while those for the low income group have convergent effects. These observations applied to both the short run and long run. For international factors, we identified intra and inter-regional flows of trade, capital, technology and related global price indices. The effects of intra-regional flows are in line with the predictions of structuralist models. In particular, the flow of intra-regional trade in high technology products has divergent effects on regional income dispersion for both the short run and long run. Other intra-regional flows such as intra-regional trade, FDI and portfolio flows have divergent long run effects. Most inter-regional flows were found to have divergent effects on intra-regional income dispersion for both the short run and long run, which may be well explained by north-south

structuralist models. The flows of inter-regional import and export in high technology products are exceptional for having convergent long run effects. The convergent long-run effects of inter-regional technology transfer are in line with the prediction of structuralist technology evolution models (Posner 196I, Freeman 1963, Hufbauer 1966 and Vernon 1966). Our regression output indicates that the energy commodity price index has convergent effects for both long run and short run. This can probably be explained by the existence of different importing and exporting structures in the high and low-income countries of Latin America and the Caribbean – one group dependent on energy consumption and the other less so.

In the third essay, the investigation was focused on the region of East and South-East Asia during the post-Bretton Woods period. We applied the same methodology and technique as that used in the second essay for convergence tests and regression analyses. With respect to the pattern of convergence, the *log t* convergence tests identified the existence of two convergence clubs in East and South-East Asia, regardless of whether per capita income was measured in US or international dollars. Regardless of the per capita income measure used, club 1 always includes the People's Republic of China, Republic of Korea, Cambodia, Indonesia, Thailand and Vietnam and club 2 always includes the China Macao, Malaysia, the Philippines and Taiwan. Both clubs have experienced rapid economic growth since 1970. On average, club 1 grew faster than club 2 (from 1970 to 2013, the average growth rate of club 1 was above 7 % while that of club 2 was around 6 %). The sigma convergence tests suggested recent income convergence in the region of East and South-East Asia but no consistent convergence over the whole period of study. For the two convergence clubs identified by the *lot t* tests, although sigma convergence tests did not

show any convergence trends for the entire period of study, they indicated that one club has been on a current convergence trend and another has remained stable over the last two decades.

The main findings from regression analyses are summarized as follows: Both domestic and international factors are related to the pattern of intra-regional income convergence in East and South-East Asia. Most domestic factors related to economic growth for the high income country group have divergent effects while those for the low income group have convergent effects, and this applied to both the short run and long run. Among intra-regional flows, intra-regional trade and intra-regional trade in high technology products have convergence effects on regional income dispersion for both the short run and long run, which is in line with the predictions of related neoclassical models. On the other hand, intra-regional financial flows (both FDI and Portfolio flows) do not have any significant long run effects on the pattern of intra-regional convergence. These financial flows probably have had comparable effects across all economies due to the characteristics of supply-chain-based production in East and South-East Asia. With respect to inter-regional flows, inter-regional import and export have quite different effects on intra-regional income dispersion. Inter-regional exports increase the dispersion of regional income for both the short run and long run. Although inter-regional imports have divergent effects for the short run, in the long run they are associated with intra-regional income convergence. Inter-regional flows of import and export in high technology products affected intra-regional income dispersion in the same way as the flows of exports and imports did. Inter-regional FDI flows have significant long run convergent effects. However inter-regional portfolio flows have long run divergence effects on intra-regional income

dispersion. This likely derives from the fact that portfolio flows are advantageous only to relatively high income countries in the region who have reached a threshold level of financial development, leading to the promotion of growth only at the upper end of the distribution of income. Energy and non-energy commodity price indices are irrelevant to regional income convergence. This is probably because East and South-East Asia have diversified import and export profiles that mute any commodity price effect.

The regression results further indicate that domestic factors usually have non-differential effects across regions while global flows are likely to have region specific effects. For the region of Latin America and the Caribbean, the effects of intra-regional flows are in line with the predictions of structuralist models while, in East and South-East Asia, intra-regional flows of trade and trade in high technology products have convergent long run effects that are more in line with the predictions of neoclassical models. With respect to inter-regional flows, the cross region differential effects are more complicated. They do not fit neatly into the predictions of any of the theoretical traditions.

Previous research on economic globalization and income convergence has been largely focused on the inter-country level. The first essay expanded both the convergence and globalization literature by examining the pattern of income convergence (or divergence) among world regions and the role of globalizing (both inter-regional and intra-regional) flows in that regard. In contrast to general studies on the effects of economic globalization or regionalization, this dissertation is the first attempt to investigate the effects of individual globalizing flows at both inter- and intra-regional levels and with

regard to the directions of these flows. The regression results prove that each individual flow behaved differently and that the effects of the same flow are usually region specific.[116]

Based on the region specific effects, this dissertation has policy implications for the regional development in Latin America and the Caribbean. In contrast to the case of East and South-East Asia, most of intra-regional flows have divergence effects on income dispersion in the region of Lain America and the Caribbean. It implies low income countries may not be able to gain as much as their rich partners do from economic regionalization in Latin America and the Caribbean. Structuralist models suggest the asymmetric structure between high and low income countries is the reason why low income countries have limited ability to benefit from economic interaction with their high income partners. Therefore policymakers need to address the structural issue which impedes low income countries' capacity to take advantage of economic regionalization.

Due to a lack of available data, the scope of this investigation has been limited to some extent. For instance, the effects of labour immigration and emigration flows could not be analyzed due to the absence of time series of inter- and intra-regional migration data. With regard to financial flows, all of the three essays focused on the effects of capital flows and ignored non-investment financial flows, such as international aid and remittances for the same reason. In the absence of a direct measure of technology transfer, in this dissertation, trade in high technology goods is used as a proxy indicator for technology

[116] For instance, the effects of portfolio flows may be different from those of FDI flows, the effects of inter-regional FDI flows may be different from those of intra-regional FDI flows and the effects of inter-regional export may be different from those of inter-regional import. Intra-regional trade has divergence effects on the region of Latin America and the Caribbean while it has convergence effects on the region of East and South East Asia.

transfer, which might affect the accuracy of the regression results. In general all of these limitations open up avenues for future research. In addition, it would be interesting to compare convergence performance and region specific effects of globalizing flows among the rest of the world regions.