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MANUFACTURING PRODUCTIVITY AND REAL CONSUMPTION WAGES

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Manufacturing productivity and real consumption wages

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Abstract

This paper examines the potential for productivity increases in developing countries to raise real consumption wages through the falling price of consumption goods. We begin by outlining the theoretical relationship between productivity and consumption before tracing the historical trends within economies as they developed throughout the twentieth century. We next examine the trends in productivity and prices across four groups of countries and economic sectors from 1970 onwards. The highest productivity growth and lowest price increases occurred in agriculture and manufacturing, with the productivity growth of emerging industrial and other developing economies improving markedly post-1990. The strongest downward effect on prices, however, remained in industrialized economies, raising questions about the role of global value chains in benefitting consumers in those economies. Examining manufacturing in further detail, we developed a conceptual outline of how productivity and price changes in consumption, intermediate and investment goods interact. We found that productivity growth in consumption goods was lower than in other categories, however, productivity increases in intermediate and investment goods within countries reduced their prices, which fed into productivity increases and lower prices for consumption goods. This benefitted industrialized and emerging industrial economies most, as developing economies did not appear to profit from the investment goods pathway. This raises further questions about the interconnections within manufacturing supply chains in and across countries.

1 Introduction

This background paper investigates the relationship between productivity increases in manufacturing and workers' real consumption wages. Given certain assumptions, as productivity increases in a country, real wages also increase because a greater volume of outputs, goods and services are produced from the same volume of inputs of capital, labour and land. The potential for productivity increases in sectors of the economy has historically depended on the potential for the industrialization of those sectors and the mass production of their output.

The quarter century after the Second World War is associated with a virtuous circle of industrialization and mass production of household durables for industrialized market economies. Productivity increases associated with economies of scale reduced the prices of mass-produced goods, stimulating demand and further market expansion. Because these industries expanded at least as quickly as the rate of productivity, manufacturing accounted for a large and stable share of employment. Wage differentials declined because employment increased more quickly in high productivity growth industries, which shared this growth with workers in the form of increasing real wages. Rising incomes and near full-employment reinforced this circle, with Keynesian macro-economic management successful at smoothing aggregate demand under such circumstances (Appelbaum and Schettkat, 1995). However, this self-reinforcing virtuous process did not last, and by the 1980s, industries with higher productivity growth no longer supported a stable share of employment. The reason for this was because the price elasticity of demand for consumer durables had declined over time as households became wealthier and accumulated a stock of such goods. Under these circumstances, continued productivity increases and price cuts in mass production industries could not increase demand and hence, labour had to be shed, moving into lower productivity growth industries. Appelbaum and Schettkat attributed this to the 'endogenous development process itself', independent of the national institutional system or specific policy mistakes that may have been made (Ibid.).

This highlights a historical period during which inclusive growth could be stimulated through the mass production of consumer goods and services. It raises the question whether such an approach—even if only a transitory period of development—could be pursued by developing countries today. However, several conditions that existed during that era no longer exist today. One of these conditions is the system of international relations, with the hegemonic power, the US, willing to fund post-war reconstruction through the Marshall Plan and open its markets to imports while tolerating trade barriers linked to the strategic industrial policy of partners. This

approach was taken to create bulwarks against communism in Europe and Japan in the period immediately following the Second World War (Fulcher, 2015). The monetary system constructed at Bretton Woods in 1944, which functioned until 1979, was also designed to subordinate international finance to national economic management and growing trade. This system has been referred to as 'embedded liberalism' (Ruggie, 1982; see Rodrik, 2012).

The neoliberal era that followed has witnessed a form of globalization that requires countries to be open to trade and foreign capital flows. This 'deep integration' (Lawrence, 1996) subjugates national economic policy to WTO rules and the need to attract and retain capital investment (Rodrik, 2012). In addition, technological advances in transport and information and communication technology (ICT) have made it much easier for economic activities to be more finely divided and dispersed between companies and across geographies. The emergence of 'global value chains' or 'global production networks' is referred to as the second 'unbundling' of production and consumption, resulting in 'trade in tasks' (Baldwin, 2009; Grossman and Rossi-Hansberg, 2008). Under these circumstances, the WTO and the OECD's recommendations for developing countries to develop have been to become part of the global value chains, even if the activities are low value added and low-skilled, because the potential to 'upgrade' the activities performed and to move up value chains exists, increasing productivity and real wages in the process (Bhatia, 2013; OECD, 2013). Others, however, have been more sceptical of this approach, emphasizing the high level of competition between suppliers at the base of value chains and the relative oligopoly of lead firms at their apex (Milberg & Winkler, 2013). Such structures in an environment of free capital flows and open trade not only make it difficult for developing countries to upgrade their activities, but may also result in productivity increases not necessarily being realized by consumers in the countries in which they occur. It depends on which markets and income level the final products are intended for, and where in the value chain the value added is captured. If competition amongst suppliers drives productivity increases, but at the same time keeps prices and margins low, those industries will not directly capture any gains. Similarly, if the end products are not for mass consumption in developing countries, the benefits for real consumption wages is limited.

Despite the industrialization challenges developing countries face today, the basic mechanism linking productivity increases to rising real consumption wages still has the potential to hold. A direct indication of this is a study of the relationship between price indices and productivity changes in different industries of national economies, which is the approach this paper follows.

The first part of the paper establishes the conceptual and theoretical foundation for the subsequent empirical investigation. A conceptual analysis of productivity is carried out in Section 2.1 to elaborate the meaning, assumptions and limitations of different types of productivity. The measures used in this investigation are also introduced. Section 2.2 outlines the wider historical trends relating productivity to structural change in countries as they develop. The relationship between productivity increases and product prices under the mainstream economic assumption of perfect competition is described in Section 2.3 before identifying a number of reasons why this automatic transmission may not hold. These include the potential of industries to generate rents, the inter-relationships between different types of products and the position of products within global value chains of production.

Next, an empirical analysis of the ideas that have been discussed is carried out. The first three sections, namely 3.1 to 3.3, examine productivity and price changes across different economic sectors at a one digit level of analysis. Section 3.1 investigates value-added labour productivity increases across four economic sectors: agriculture, manufacturing, non-manufacturing and services for four country groups over 42 years: industrialized, emerging industrial, developing and least developed countries. Section 3.2 examines changes in the value-added price indices for these same sectors, country groups and years. Section 3.3 regresses changes in the value-added price index upon changes in value-added labour productivity for the economy's 1-digit sectors combined and for the manufacturing sector as a whole.

The subsequent four sections examine productivity and price changes within the manufacturing sector at a greater level of detail. Section 3.4 examines output labour productivity increases, dividing the manufacturing sector into 23 industries and three categories: consumption goods, intermediary goods and investment goods, the latter further divided into electrical and communication equipment. Section 3.5 examines output and value-added price changes for these same sectors, country groups and years finding similar patterns irrespective of the price index used. Sections 3.6 to 3.7 model the relationship between productivity and price changes at this further level of disaggregation of the manufacturing sector. Section 3.6 outlines a simple flow model which relates price and productivity changes in each of the three manufacturing categories: consumption goods, intermediary goods and investment goods. A series of regression equations are thus derived, which allow investigation of the relationship between productivity and price changes in these manufacturing categories and ultimately, how this relates to the price of consumption goods for each country type. The results are presented and discussed in Section 3.7. Two additional model specifications, one using a mix of current and

lagged independent variables and one using a simultaneous structural equation model (SEM) are provided in the appendices. Finally, the results are discussed in the conclusion.

2 Conceptual framework

2.1 Meanings and measures of productivity

At the most basic level, productivity is a real measure of output produced per input used. However, there are different conceptual measures for the numerator 'output' and the denominator 'input' as well as challenges in measuring them, which will be briefly addressed in this section. Productivity is referred to as a 'real' measure because output and input are volume measures, with any change in those measures being conceptually independent of changes in price or quality.

The majority of volume series of output are estimated by deflating value data (quantity multiplied by price) by price indices, because it is easier to calculate price indices than to directly measure volume changes. However, industries in which prices change rapidly pose a further challenge. Recent advances in national accounting try to minimize the problem of outdated prices distorting volume estimations by holding prices fixed for a maximum of one year, calculating volume changes for each year separately, and then chain-linking these changes together. However, different national accounting agencies implement different methods of calculation at different times, meaning that some countries and periods use fixed base years of prices for several years of calculation (see UN, 2015 for details on each country's calculation method). It should be noted that volume measures are always dependent on the base year of prices chosen and on the assumption that this is an equilibrium measure of consumer utility, which has led some critics to argue that volume measures are never truly independent of prices (Nitzan and Bichler, 2009).

It is more challenging to define a volume output in certain industries than in others. Defining a volume output requires the establishment of a standard 'base' product or service where the differences in quality can be viewed as a multiple of that base and hence counting a total number of units is at least possible conceptually. Such a calculation is most straightforward for narrowly defined 'product' industries. For service industries, the standard base service (and its price) must first be determined to define a volume output. This is not particularly challenging for industries in which the service or product is relatively standardized, for example, types of communication. However, there are service industries in which no standard service is obvious, with professional or financial services being prime examples. In such cases, it is not always clear what prices should be held constant to estimate changes in volume. Such a measurement is

clearly more difficult for non-market industries, for example, universally provided public services, where no market prices of output exist. In these industries measuring volume requires defining the most relevant outputs and establishing the necessary statistical infrastructure to measure this directly. This project has been ongoing in several developed countries for some time (e.g. O'Mahoney and Timmer, 2009). However, due to the lack of standardization of the measures used across countries and patchiness in data collection, non-market services are often excluded from productivity measures and comparisons.

Thus far, we have considered the numerator in the calculation of productivity as the direct measure of (gross) output. However, this measure has limitations. While attempting to measure the volume of output, the intermediate goods used in production are not accounted for and hence the measure does not reflect the economic activity that has actually been performed in a given location.[1] That is, volume measures for gross output are the same, regardless whether all stages of production take place in a country or whether only the final assembly of intermediate products is performed, although the workers and capital involved in the former would clearly be greater than in the latter. Hence, a more commonly used measure of output is 'value added', which is used in the compilation of national accounts from the production perspective. This is the value of output (price multiplied by quantity) minus the value of intermediate goods used in production. The challenge when using this measure is that in order to calculate it in terms of volume requires having price indices for both the final and intermediate goods for each sector to deflate value indices. This data is not always available for each country and sector. In this paper, we use value added volume measures of output where the data is available, in particular for the higher level 1-digit definition of industries. Where value added volume measures are not available, we use output estimates, which is the case for the two-digit analysis of manufacturing industries. The price indices constructed are also value added as this data is more readily available than output price indices alone.

When considering the denominator of the productivity calculation, i.e. the inputs, single factors of production or multiple factors combined can be used. The factors based on economic theory are capital and labour, and are used to calculate capital and labour productivity, respectively. Multi or total factor productivity uses a combined quantity index of capital and labour as inputs.

Conceptually, single factor measures of productivity do not directly measure the productive efficiency of that particular factor input, the workers or capital. They are an aggregate measure of output (for example, value added, as discussed above) over a single type of input. This will

[1] With the exception of multifactor productivity KLEMS.

be affected by the quantity of the other factor input used, as well as other factors that affect efficiency, including the organization of production, economies of scale, technology not directly represented in the measure of capital, and the degree of capacity utilization. Labour productivity may, for example, be increased by workers who work harder but also by increasing the quantity or quality of capital employed, by re-organizing or expanding production and operating closer to the so-called production frontier of full capacity utilization.

Multi-factor productivity measures attempt to isolate those characteristics that affect productivity, which are *not* influenced by increasing the quantity of labour and capital involved in production. This is sometimes thought to represent technological change, however, it is a very specific notion of the development of technology. It does not measure technological change as *embodied* in capital goods because this is measured as a quantity of capital. Rather it measures *disembodied* technological change of the sort that might be reflected in changes in organization, economies of scale, etc. Measuring multi-factor productivity requires indices of both labour and capital input, which are not always available for every country.

In terms of measurement, labour is the most commonly used input, largely for reasons of data availability. In this case, however, we have a range of measures. Labour can be measured as the number of workers in a given period, for example, in one year or quarter, the number of full-time equivalent workers (FTEs) or most accurately their total quantity of labour hours. The most widely available data is the number of workers (ILO, 2015) or employees (UNIDO, 2016) by industry per year, and we therefore use these inputs in our calculation of labour productivity. While these are measures of quantity, they do not distinguish between quality, types or skills of workers. Regardless which measure of productivity is being examined, it is clear that productivity increases have historically been associated with industrialization and mass production. This requires the application of technologies of standardization, automation, communication and information processing to facilitate changing the organization of production from craft-based networks to large-scale centralized, hierarchical organizations. Industrial corporations have internal economies of scale, producing large volumes at lower margins. Such industrialization requires greater capital intensity of production with a suitably skilled workforce willing to be managed in this way. There is no single model for achieving this, it depends on the regulatory and institutional framework of the given country, which determines the degree of inter-company competition, the nature of education and training and the labour-capital relationship (Broadberry, 2006: chs.5-7; Hall and Soskice, 2001).

2.2 Historical trends in productivity

When considering changes in productivity and the structural transformation of economies over time, one standard way of categorizing industries is in terms of agriculture, manufacturing and services. Long-run stylized facts for both currently rich and poor countries indicate that as countries become more developed, their share of employment and value added alters between sectors. As countries develop, their internal share of employment and value added for agriculture reduces, it increases but then decreases for manufacturing (resembling a hump shape), and increases for services. The same pattern may be observed within countries over time if they are on an upward trajectory of development. These stylized facts seem to broadly hold; irrespective of the time period and countries included, there is a strong relationship with the level of development measured in terms of GDP per capita (see Herrendorf et al., 2014). [2]

Such structural change as economies grow is at least partially related to differential productivity growth within economic sectors. [3] It has been argued, particularly in the work of William Baumol, that different sectors are more inherently amenable to productivity growth than others. Agriculture underwent a technological revolution in developed countries first, characterized by mechanization, economies of scale and the use of targeted fertilizers. These technologies continued to develop as new ones, such as genetically modified crops and GPS equipped machinery, were introduced. Such advances have reduced the value added, consumption and employment shares of workers in developed economies that produce food.

With the technological revolution in agriculture having occurred first, most of the post-war discussion on productivity growth has focused on manufacturing and services. Baumol initially held the view that manufacturing was the only 'progressive' sector due to its amenability to economies of scale and technological innovation. Services, in contrast, were considered to be 'stagnant', having little or no capacity for productivity increases (Baumol, 1967). [4] This is because "it is essentially the labour effort itself we wish to consume" in services (Pierson, 2001:84). This is not entirely accurate as it is actually a subset of services, perhaps best labelled 'personal services'. In fact, the distinction between manufacturing and services has not been rigid over time, not least because of the tendency of the vertical integration of production and

[2] The availability of historical data for rich countries reaches back much farther than for poor countries (1800–2000). Detailed data from EU-KLEMS covers relatively rich countries from the 1970s while less detailed UN data covers a matched panel of rich and poor countries from 1975–2005 (see Herrendorf et al., 2014).

[3] In terms of this analysis, it should not matter what measure of productivity is being used, in this case it is labour productivity using value added as the output measure and the number of workers as the input. The important point is that the same ratio of output to inputs is changing differently in different parts of the economy.

[4] In Baumol's later work, a third 'asymptotically stagnant' sector was added, combining some progressive inputs with some stagnant ones. However, over time, the stagnant elements have come to dominate with initially rapid productivity growth reducing towards a stagnant asymptote (Baumol et al., 1985).

related services in large corporations throughout the 20th century. Although this strategy is no longer being pursued by Western corporations, horizontal and vertical integration is quite common among South-East Asian companies, with the Japanese 'model of capitalism' being highly influential. Edward Wolff (1999), for example, includes a number of services related to manufacturing in his category of 'goods' industries. In comparing the UK's long-run productivity increases with those of Germany and the US, Stephen Broadberry (2006) highlights the importance of productivity increases in the 'market services' industries of 'transport and communications', 'distribution' and 'finance, professional and personal services'. The first two industries industrialized a long time ago in developed countries, registering increases in productivity. For example, Chandler (1977) asserts that it was the railroads in the US during the latter half of the 19th century, which initiated the hierarchical organization and established a mass market for goods. However, it is important to note that each of these market services is related to manufacturing in that they have played a significant role in establishing more efficient and geographically distributed hierarchical organizations and markets for products, capital and—perhaps with the rise of global value chains—increasingly labour.

More recently, studies have begun exploring the capacity of advances in new ICTs to increase productivity in certain market services, particularly in finance, professional and personal services, which have also become increasingly standardized and hence 'industrialized'. Several empirical studies argue that labour productivity in market services has been *increasing* across the US and Europe since the 1990s, due to investment in ICT and human capital (Inklaar, Timmer & van Ark, 2008; Jorgenson and Timmer, 2011; Triplett & Bosworth, 2004; 2006).

The long-term patterns of structural change are consistent with productivity growth and falling consumption prices that occur in agriculture and manufacturing as countries develop. The extent to which productivity growth automatically results in falling prices and how this affects employment and wages will be discussed further in the next section. Historically, Appelbaum and Schettkat (1995) depict Salter's and Reddaway's (1960) study of the UK between 1928 and 1950, and the 25-year post-war 'Golden Age' of industrialized countries as a period when rapid productivity growth driven by economies of scale in manufacturing and related sectors resulted in falling prices. This expanded the markets for mass-produced goods, because both the price and income elasticity of demand were high. Hence, manufacturers could pass on productivity increases to consumers in the form of reduced prices, thus stimulating demand and resulting in an expansion of production and the employment of more workers. There was a virtuous circle between productivity increases in manufacturing, full employment, increasing real wages and economic growth, with Keynesian demand management policies being applied as required to

smooth and sustain this circle. In Scandinavian countries, particularly in Sweden, the Rehn-Meidner model of industrial development was implemented to varying degrees at different points in time. This model actively pursued solidaristic wages as a means of industrial development. Restrained wages in progressive and often export-oriented industries improved competitiveness and profitability, while relatively high wages in more stagnant industries forced improvements in production or drove companies out of business, reallocating labour to the productive sectors. This model went hand-in-hand with a large public sector, funded in part by taxes on rents from the competitive sector. It was broadly accepted based on the recognition that the public sector generates positive externalities by supporting families in their crucial reproductive role, and contributing to the generation of competitive advantage within national systems of innovation (Mahon, 2007; Lewis, Ryner and Peng, 2017).

However, by the 1970s and 1980s, the virtuous circle of productivity increases, growing demand, economic growth and rising employment could no longer hold for the majority of developed countries. Productivity increases in manufacturing industries still led to price decreases, thereby raising real consumption wages, but this no longer sufficed to increase consumer demand. Appelbaum and Schettkat understand this as a decline in the absolute price elasticity of demand for manufactured goods, implying a degree of consumer saturation with such products. The consequence was that developed countries entered the downward phase of the manufacturing hump, reducing its share of employment and value added.

Throughout the entire period, certain personal services were relatively stagnant in terms of productivity growth, hence, their prices necessarily increased relative to agriculture and manufacturing. While certain services were priced out of the market, for example, domestic servants and railway porters in developed countries (Appelbaum and Schettkat, 1995), relatively price inelastic demand for other services, such as retail or higher education (Baumol, 1967) meant that these took an increasing share of expenditure, value added and employment.

2.3 Productivity, prices and the real consumption wage

The trends discussed in the previous section suggest that as productivity increases in a sector of the economy—in this case, a measure of labour productivity—its price falls because unit costs have decreased. For this to occur, companies that are experiencing increased productivity, perhaps through innovation of some sort, must face pressures to reduce their prices in line with their costs. In mainstream economics, this situation is depicted in terms of ‘perfect competition’. Within this ideal framework, the price of outputs (goods and services) and of factor inputs (capital and labour) is determined simultaneously in economy-wide markets, which balance

aggregate supply and demand and cannot be influenced by the decisions of individual firms. Every firm optimizes its production by employing a quantity of each factor input until the cost of an additional unit equals precisely the value of additional output produced. The value of output produced (price multiplied by volume) exactly equals the payments to each factor input, i.e. there is no surplus. If one firm increases its labour productivity, perhaps due to technological innovation, it will produce more physical units of output per worker than before. Under perfect competition, factor markets will be largely unaffected since the supply and demand for labour and capital in the whole economy largely remain the same, hence, nominal wages and return on capital should also remain unchanged. Under perfect competition, the innovation implemented by that firm would be rapidly copied by the other firms in the industry or adopted by new entrants. It is this competition that should drive down the market price to its new (marginal) cost of production, passing on the increase in productivity as a saving to the consumer.

Considering the effect of this development on real wages, the 'real product wage' of workers in the industry, i.e. the number of units of directly produced output that the wage they earn can purchase, will increase in accordance with the rise in productivity. Nominal wages will essentially remain unchanged. 'Real consumption wages', which is what matters most to workers and is defined as the nominal wage divided by the price index of a basket of consumption goods, will increase slightly, to the extent that the product produced by that industry is included in the consumption basket. However, this increase in 'real consumption wage' will be the same for all workers in their dual role as consumers and workers in the productivity increasing industry. According to competitive theory, real product wages should increase proportionally to increasing sectoral productivity, but this increases the real consumption wage of all workers equally. A further consequence is that the labour and capital share of output remains stable (Glyn, 2009).[5] Departures from this equilibrium result in either a 'profits squeeze' or a declining labour share, and are usually attributed to market imperfections.

The logic of this analysis suggests that productivity increases should provide a consumption benefit in the location where they occur. However, this depends on several assumptions. Competition (i.e. the firm producing the good) must ensure that any productivity increases are fully or at least partially passed on to the consumer as price decreases and should not be used to raise its own profitability, generating sectoral rents (Lewis, Peng and Ryner, 2017).

[5] The functional distribution of output only makes conceptual sense at the level of the entire economy, because the factor rewards of labour and capital are determined in economy-wide markets. However, the same reasoning would also apply to sectors if industry-specific factor rewards were determined at this level of analysis.

A second factor is the nature of the product itself. Productivity increases and price decreases in goods that are directly consumed, namely 'consumption goods', directly boost the real consumption wage. However, it is also possible that price decreases in 'intermediate goods', i.e. goods that are subsequently subsumed to produce a final product or 'investment goods', namely capital equipment that can be used in multiple cycles of production, could also indirectly benefit real wages. This is because productivity increases and price decreases in intermediate products could ultimately reduce costs and lower the prices of final consumption goods, and in the case of investment goods, increase productivity and reduce costs in other industries which employ them. However, this also depends on the geography of the 'chain' of production and the capacity of different producers in the chain to generate rents. This brings us to the third consideration – the fragmentation and globalization of production.

The theory of perfect competition elaborated above generally assumes that final products are produced and consumed in the same location. However, advances in ICTs and reductions in both trade barriers and capital restrictions have fragmented production, which can now be outsourced by lead firms and distributed across multiple locations to benefit from the advantages offered by specific locations while still being tightly managed and meeting specific criteria (Gereffi et al., 2005). One argument of particular relevance here is that lead firms have been able to exert power over rents further down the value chain in activities outsourced to suppliers in developing countries. Intense competition between suppliers and limited competition between lead firms has resulted in productivity increases being translated into price decreases for suppliers and lower input prices for lead firms in developed economies (Milberg & Winkler, 2013). This has allowed lead firms to lower prices for Western consumers and at the same time, increase the profit share as wages have been stagnant and have become more precarious in developed economies.

3 Empirical analysis

The discussion above reveals that there are a number of relevant questions that need to be explored empirically. First, we analyse which industries registered the greatest increases in labour productivity in recent years and whether differences by type of country are evident. Second, we examine which industries and countries recorded the largest price decreases. Third, we perform some basic regression analysis to study the impact of changes in labour productivity on changes in price indices. These changes are initially examined at a high level of industry categorization (1-digit level), for which publicly available standardized data is available for a large number of countries over a long period of time (see Sections 3.1 to 3.3). A regression analysis is then performed for the manufacturing sector at a lower level of industry

categorization, with manufacturing industries grouped into consumption, intermediate and investment goods (Sections 3.4 to 3.5). This requires the use of different data sources and reduces the number of countries and years for which data is available.

Fourth, we explore the inter-relationship between price and productivity changes in each type of manufactured good upon the price of consumption goods within each group of countries. Section 3.6 outlines the potential links between price and productivity changes between the three different groups of manufacturing industries: consumption goods, intermediate goods and investment goods. Section 3.7 presents the results of tests of the potential links using two-digit industry data. The appendices contain analysis of the potential links in Section 3.6 using lagged independent variables and a system of simultaneous equations (SEM) to control for potential endogeneity problems.

The country categorization (four categories) we use is based on stage of industrialization following Upadhyaya (2013). Industrialized and emerging industrialized countries are determined using thresholds of manufacturing value added (MVA) per capita or GDP per capita adjusted for PPP. Least developed countries (LDCs) are determined by the UN General Assembly, whilst other developing countries have not yet reached the threshold to be classified as emerging industrialized countries.

3.1 Productivity analysis at the one-digit industry level

In our initial analysis, we use UN National Accounts Statistics, namely the main aggregates and detailed tables for real value added data in 2005 US$ at one-digit combinations of the International Standard Industrial Classification (ISIC 3.1) coding. This includes 220 countries over the period 1970 to 2014. The quality of the data varies by country and period, as the periods for which fixed base years of prices were used and the availability of deflators for both outputs and inputs in value added varies (see UN, 2015 for details on each country calculation). Value added is converted into a labour productivity measure using data on the number of workers (UNIDO, 2016). When combining the two data sources, we had data for 129 countries across four high-level industry groups for the period 1970–2012. We weighted the value added labour productivity data for each country/industry combination based on its average share in each industry's total current price value added over the period. This means that larger producing countries will have a greater weight than smaller ones in productivity calculations for each country group and industry. At an aggregate level, the weights approximate the GDP shares of each country.

The results for this initial analysis are presented in Table 1, first for the longest period available, 1970–2012 and then split into two sub-periods, namely 1970–1990 and 1991–2012.

Table 1a **Average annual percentage change in 2005 US$, VA labour productivity, 1970–2012, 129 countries**

Industry	Industry Code (ISIC 3.1.1)	Country Group				
		Industrialized Economies	Emerging Industrial Economies	Other Developing Economies	Least Developed Countries	Total
Agriculture	A+B	3.56	2.67	1.58	0.76	2.78
Manufacturing	D	3.22	2.36	1.63	-0.35	3.00
Non-manufacturing	C+E+ F	0.40	0.22	-1.74	-1.23	0.14
Services	G-P	1.02	1.12	0.69	0.73	1.02
Total	A-P	1.39	1.32	0.22	0.41	1.31

Source: Authors' elaboration based on INDSTAT2 ISIC, Rev. 3. database (UNIDO, 2016). Value added data (in 2005 US$) is adapted from the National Accounts Main Aggregates Database, United Nations Statistics Division, ©2015 United Nations. Reprinted with the permission of the United Nations.

Table 1b **Average annual percentage change in 2005 US$, VA labour productivity, 1970–1990, 129 countries**

Industry	Industry Code (ISIC 3.1.1)	Country Group				
		Industrialized Economies	Emerging Industrial Economies	Other Developing Economies	Least Developed Countries	Total
Agriculture	A+B	4.58	1.83	1.37	-0.18	2.65
Manufacturing	D	3.57	1.36	1.56	-2.53	3.11

Non-manufacturing	C+E+ F	1.49	-1.16	-2.78	0.12	0.41
Services	G-P	1.40	0.41	-0.18	-0.97	1.16
Total	A-P	1.87	0.43	-0.52	-0.84	1.45

Source: Authors' elaboration based on the INDSTAT2 ISIC, Rev. 3. database (UNIDO, 2016). Value added data (in 2005 US$) is adapted from the National Accounts Main Aggregates Database, United Nations Statistics Division, ©2015 United Nations. Reprinted with the permission of the United Nations.

Table 1a **Average annual percentage change in 2005 US$ VA, labour productivity, 1991-2012, 129 countries**

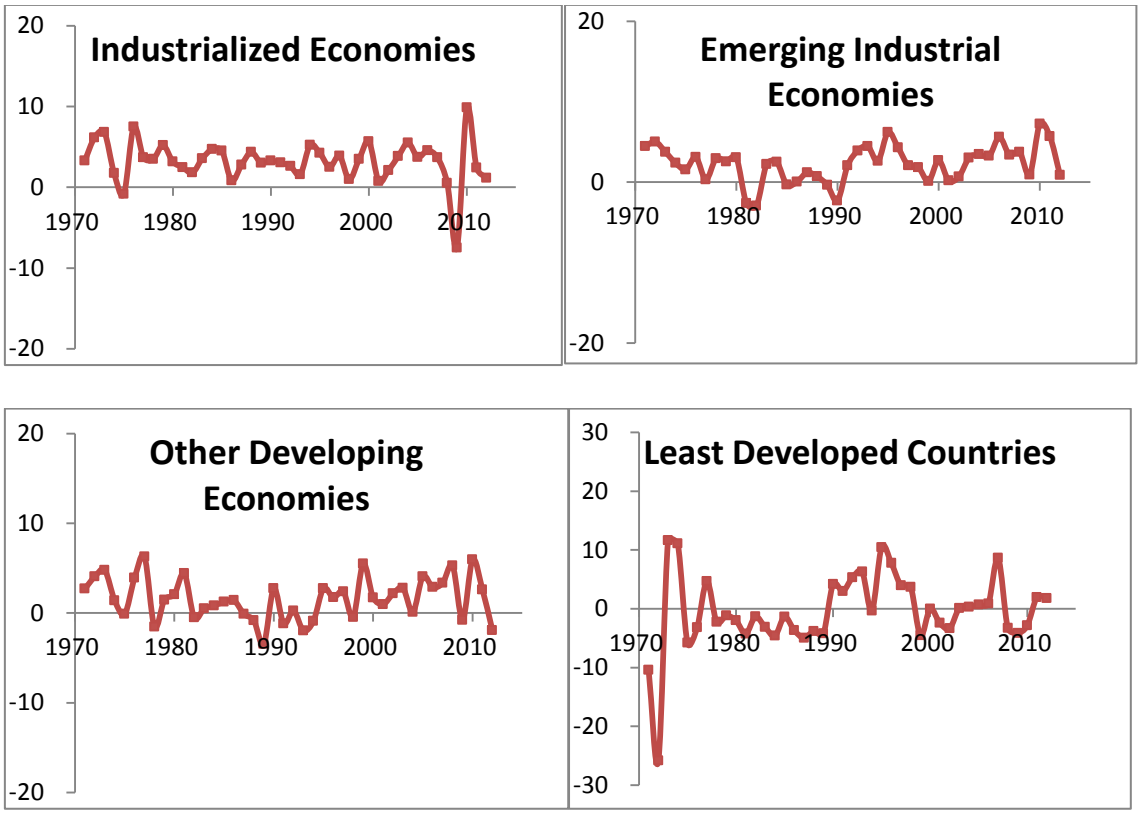
Industry	**Industry Code (ISIC 3.1.1)**	**Country Group**				
		Industrialized Economies	**Emerging Industrial Economies**	**Other Developing Economies**	**Least Developed Countries**	**Total**
Agriculture	A+B	2.68	3.42	1.77	1.54	2.88
Manufacturing	D	2.90	3.17	1.70	1.53	2.91
Non-manufacturing	C+E+ F	-0.57	1.43	-0.81	-2.13	-0.09
Services	G-P	0.68	1.76	1.46	2.11	0.90
Total	A-P	0.96	2.11	0.88	1.43	1.20

Source: Authors' elaboration based on the INDSTAT2 ISIC, Rev. 3. database (UNIDO, 2016). Value added data (in 2005 US$) is adapted from the National Accounts Main Aggregates Database, United Nations Statistics Division, ©2015 United Nations. Reprinted with the permission of the United Nations.

Agriculture and manufacturing clearly achieved the highest productivity growth over each time period for industrialized, emerging industrial and other developing economies. The performance of emerging industrial economies improved in the second period, surpassing the productivity growth of industrialized economies, while other developing economies also improved. Least developed countries had more volatile results but this could be attributable to the relatively small sample of countries and the quality of the available data. Services recorded the next strongest productivity growth across country groups overall and in the latter half of the period.

However, these average annual changes mask a substantial amount of year-to-year volatility in productivity. The figures below illustrate the year-to-year percentage changes in labour productivity in manufacturing for each of the country groups.

Figure 1 **VA 2005 US$ labour productivity change in manufacturing by country group, 1970-2012, 129 countries**



Source: Authors' elaboration based on the INDSTAT2 ISIC, Rev. 3. database (UNIDO, 2016). Value added data (in 2005 US$) is adapted from the National Accounts Main Aggregates Database, United Nations Statistics Division, ©2015 United Nations. Reprinted with the permission of the United Nations.

We clearly see the effects of the financial crisis of 2007-9 in all countries, namely a significant downturn followed by volatility. However, the severity of the drop and subsequent temporary rebound was largest in industrialized countries, likely indicating the effect of Keynesian style government stimulus in many of these countries.

3.2 Price analysis at the one-digit industry level

Examining changes in VA price indices for the same sectors, country groups and periods yields the following results:

Table 2a Average annual percentage change in VA price index, 1970-2012, 129 countries

Industry	Industry Code (ISIC 3.1.1)	Country Group				
		Industrialized Economies	Emerging Industrial Economies	Other Developing Economies	Least Developed Countries	Total
Agriculture	A+B	3.02	3.48	3.16	3.07	3.26
Manufacturing	D	3.68	3.31	3.39	3.26	3.60
Non-manufacturing	C+E+ F	5.84	5.77	6.70	4.23	5.90
Services	G-P	5.12	4.17	3.61	3.17	4.89
Total	A-P	4.91	4.25	4.41	3.25	4.74

Source: Authors' elaboration based on the INDSTAT2 ISIC, Rev. 3. database (UNIDO, 2016). Value added data (real in 2005 US$, nominal in current US$) is adapted from the National Accounts Main Aggregates Database, United Nations Statistics Division, ©2015 United Nations. Reprinted with the permission of the United Nations.

Table 2b Average annual percentage change in VA price index, 1970-1990, 129 countries

Industry	Industry Code (ISIC 3.1.1)	Country Group				
		Industrialized Economies	Emerging Industrial Economies	Other Developing Economies	Least Developed Countries	Total
Agriculture	**A+B**	6.39	3.75	3.87	4.90	4.70
Manufacturing	**D**	7.30	5.41	4.19	5.36	6.86
Non-manufacturing	**C+E+ F**	9.32	7.24	7.23	4.85	8.57
Services	**G-P**	8.79	4.50	4.29	4.43	7.85
Total	**A-P**	8.54	5.04	5.07	4.74	7.64

Source: Authors' elaboration based on the INDSTAT2 ISIC, Rev. 3. database (UNIDO, 2016). Value added data (real in 2005 US$, nominal in current US$) is adapted from the National Accounts Main Aggregates Database, United Nations Statistics Division, ©2015 United Nations. Reprinted with the permission of the United Nations.

Table 2c Average annual percentage change in VA price index, 1991-2012, 129 countries

Industry	Industry Code (ISIC 3.1.1)	Country Group				
		Industrialized Economies	Emerging Industrial Economies	Other Developing Economies	Least Developed Countries	Total
Agriculture	**A+B**	0.34	3.25	2.60	1.67	2.10
Manufacturing	**D**	0.74	1.77	2.75	1.59	1.01
Non-manufacturing	**C+E+ F**	3.05	4.59	6.27	3.84	3.76
Services	**G-P**	2.12	3.90	3.07	2.21	2.47
Total	**A-P**	1.95	3.62	3.88	2.14	2.39

Source: Authors' elaboration based on the INDSTAT2 ISIC, Rev. 3. database (UNIDO, 2016). Value added data (real in 2005 US$, nominal in current US$) is adapted from the National Accounts Main Aggregates Database, United Nations Statistics Division, ©2015 United Nations. Reprinted with the permission of the United Nations.

We see different levels of average price inflation depending on country group and period. For example, it was significantly higher for industrialized economies between 1970 and 1990, consistent with the geopolitics and oil price crises of that era, but this reversed in later periods, during which the development of global value chains may well have benefitted the consumers in those countries. Within these macro trends—and observable for all country groups—we find that increases in the VA price index have been consistently lower for agriculture and manufacturing than for other industries. This is in line with higher productivity growth in these industries, translating into lower price growth. Services also had consistently lower price increases than the non-manufacturing industries of 'mining and quarrying', 'electricity, gas and water supply' and 'construction'.

3.3 Relationship between productivity and price increases at the one-digit industry level

Our initial analysis is at the 1-digit industry level for all sectors of the economy combined. We first compare the levels in each variable using the regression (1) below:

$$\ln VAP_{cit} = \beta_0 + \beta_1 \ln LP_{cit} + \eta_c + \eta_i + \eta_t + \eta_{cit} \quad (1)$$

Following Islam (1995) and Durlauf et al. (2009), we can first difference equation (1) to develop the equation:

$$d\ln VAP_{cit} = \beta_0 + \beta_1 d\ln LP_{cit} + \eta_c + \eta_i + \eta_t + \eta_{cit} \quad (2)$$

The difference of the ln form is its annual growth rate. Year dummy variables capture potential year fixed effects operating across all industries and countries that might influence the relationship between the variables being examined. We did not change the constant and stochastic error term for simplicity. The variables have been constructed as follows:

dlnVAP – Change in ln of the value added price index calculated using UN, 2015 for nominal VA converted from national currencies into current US$ and real VA in 2005 US$.

dlnLP – Change in ln of the value added labour productivity calculated using UN, 2015 for real VA in 2005 US$ and UNIDO, 2016 for the number of workers.

The subscripts represent country c, industry i and year t, hence $\ln VAP_{cit}$ is the ln form value added price index in country c, industry i and year t. $\ln LP_{cit}$ is the ln form labour productivity for country, industry and year; η_t are year dummies to control for time dynamics, η_i are industry dummies to control for industry effects, η_c are country dummies and η_{cit} is the stochastic error term.

The results for each of the country groups across all 1-digit industry groups as recorded by the UN are shown in Table 3a. The results for the 1-digit manufacturing industries are presented in Table 3b. The coefficients may be interpreted as the percentage change in the VA price index for a 1 per cent change in VA labour productivity. The standard errors are shown below each coefficient.

Table 3a **Change in 1-digit industry ln VA price indices (current price US$) regressed upon change in ln labour productivity (real VA (2005 US$)/No. employed), 129 countries, 1970-2012, 4 sectors**

dlnVAP	All	Industrialized Economies	Emerging Industrial Economies	Other Developing Economies	Least Developed Countries
dlnLP	-0.144***	-0.212***	-0.107***	-0.152***	-0.166***
	(0.013)	(0.023)	(0.029)	(0.016)	(0.023)
Country dummy	yes	yes	yes	yes	yes
Year dummy	yes	yes	yes	yes	yes
Industry dummy	yes	yes	yes	yes	yes
R-squared	0.325	0.555	0.201	0.172	0.158
N	19679	5876	4325	6790	2688

Source: Authors' elaboration based on the INDSTAT2 ISIC, Rev. 3. database (UNIDO, 2016). Value added data (real in 2005 US$) is adapted from the National Accounts Main Aggregates Database, United Nations Statistics Division, ©2015 United Nations. Reprinted with the permission of the United Nations.

Table 3b **Change in 1-digit industry ln VA price indices (current price US$) regressed upon change in ln labour productivity (real VA (2005 US$)/No. employed), 129 countries, 1970-1990, 4 sectors**

dlnVAP	All	Industrialized Economies	Emerging Industrial Economies	Other Developing Economies	Least Developed Countries
dlnLP	-0.230***	-0.272***	-0.054	-0.293***	-0.256***
	(0.021)	(0.037)	(0.048)	(0.024)	(0.036)
country dummy	yes	yes	yes	yes	yes
year dummy	yes	yes	yes	yes	yes
industry dummy	yes	yes	yes	yes	yes
R-squared	0.357	0.587	0.234	0.250	0.177
N	8456	2560	1820	2876	1200

Source: Authors' elaboration based on the INDSTAT2 ISIC, Rev. 3. database (UNIDO, 2016). Value added data (real in 2005 US$) is adapted from the National Accounts Main Aggregates Database, United Nations Statistics Division, ©2015 United Nations. Reprinted with the permission of the United Nations.

Table 3c **Change in 1-digit industry ln VA price indices (current price US$) regressed upon change in ln labour productivity (real VA (2005 US$)/No. employed), 129 countries, 1991-2012, 4 sectors**

dlnVAP	All	Industrialized Economies	Emerging Industrial Economies	Other Developing Economies	Least Developed Countries
dlnLP	-0.128***	-0.196***	-0.172***	0.003	-0.101***
	(0.016)	(0.030)	(0.035)	(0.022)	(0.031)
Country dummy	yes	yes	yes	yes	yes
Year dummy	yes	yes	yes	yes	yes
Industry dummy	yes	yes	yes	yes	yes
R-squared	0.255	0.417	0.186	0.118	0.142
N	11223	3316	2505	3914	1488

Source: Authors' elaboration based on the INDSTAT2 ISIC, Rev. 3. database (UNIDO, 2016). Value added data (real in 2005 US$) is adapted from the National Accounts Main Aggregates Database, United Nations Statistics Division, ©2015 United Nations. Reprinted with the permission of the United Nations.

The results are indicative of a general statistically significant negative effect of productivity increases on prices across all country groups. The reduction in price indices is largest for industrialized economies in each period while this effect became much stronger in emerging industrial economies during the second period and weaker for other developing economies. However, there are potential endogeneity issues between price and labour productivity, including possible reverse causation, which may bias the results. We next look at the subset of 1-digit manufacturing:

Table 4a **Change in 1-digit manufacturing industry ln VA price index (current price US$) regressed upon change in ln labour productivity (real VA (2005 US$)/No. employed), 129 countries, 1970-2012**

dlnVAP	All	Industrialized Economies	Emerging Industrial Economies	Other Developing Economies	Least Developed Countries
dlnLP	-0.191***	-0.216***	-0.087	-0.127***	-0.120***
	(0.025)	(0.044)	(0.062)	(0.035)	(0.033)
Country dummy	yes	yes	yes	yes	yes
Year dummy	yes	yes	yes	yes	yes
R-squared	0.378	0.566	0.209	0.079	0.215
N	4894	1469	1055	1698	672

Source: Authors' elaboration based on the INDSTAT2 ISIC, Rev. 3. database (UNIDO, 2016). Value added data (real in 2005 US$) is adapted from the National Accounts Main Aggregates Database, United Nations Statistics Division, ©2015 United Nations. Reprinted with the permission of the United Nations.

Table 4b **Change in 1-digit manufacturing industry ln VA price indices (current price US$) regressed upon change in ln labour productivity (real VA (2005 US$)/No. employed), 129 countries, 1970-1990**

dlnVAP	All	Industrialized Economies	Emerging Industrial Economies	Other Developing Economies	Least Developed Countries
dlnLP	-0.259***	-0.287***	-0.127	-0.064	-0.233***
	(0.046)	(0.077)	(0.105)	(0.075)	(0.063)
Country dummy	yes	yes	yes	yes	yes
Year dummy	yes	yes	yes	yes	yes
R-squared	0.378	0.589	0.169	0.073	0.306
N	2099	640	440	719	300

Source: Authors' elaboration based on the INDSTAT2 ISIC, Rev. 3. database (UNIDO, 2016). Value added data (real in 2005 US$) is adapted from the National Accounts Main Aggregates Database, United Nations Statistics Division, ©2015 United Nations. Reprinted with the permission of the United Nations.

Table 4c **Change in 1-digit manufacturing industry ln VA price indices (current price US$) regressed upon change in ln labour productivity (real VA (2005 US$)/No. employed), 129 countries, 1991-2012**

dlnVAP	All	Industrialized Economies	Emerging Industrial Economies	Other Developing Economies	Least Developed Countries
dlnLP	-0.157***	-0.162***	-0.048	-0.142***	-0.093**
	(0.030)	(0.054)	(0.079)	(0.037)	(0.041)
Country dummy	yes	yes	yes	yes	yes
Year dummy	yes	yes	yes	yes	yes
R-squared	0.273	0.402	0.209	0.083	0.073
N	2795	829	615	979	372

Source: Authors' elaboration based on the INDSTAT2 ISIC, Rev. 3. database (UNIDO, 2016). Value added data (real in 2005 US$) is adapted from the National Accounts Main Aggregates Database, United Nations Statistics Division, ©2015 United Nations. Reprinted with the permission of the United Nations.

The results are again indicative of a general statistically significant negative effect of productivity increases on price indices across all country groups, with the strongest effect evident in industrialized economies. Interestingly, the results are not statistically significant for emerging industrial economies or other developing economies in the earlier period. This may indicate the breaking of a clear transmission mechanism from productivity increases to price decreases for the manufacturing industries in these countries, discussed in Section 2.3 and in Section 3.6, which sets out the potential relationships between productivity and price changes for the different categories of manufacturing products.

3.4 Analysis of productivity changes in manufacturing at the two-digit industry level

While the high-level industry analysis indicates the capacity of manufacturing to achieve productivity increases across the four country groups and the degree to which emerging industrial and industrial countries have been most successful in this regard, it is important to move down one level to determine whether certain manufacturing industries have had greater productivity increases than others.

Our data source is a 2-digit ISIC revision 3.1 index of industrial production (IIP) (UNIDO, 2016). We use this as a proxy for real output since real value added data cannot be calculated at

this level of industry disaggregation. The IIP can be converted into data on change in real output labour productivity using the number of employees data for 23 manufacturing industries (Table 5). The period selected is 1991 to 2013 for a good coverage of countries and years. Notable countries and years that are missing include: Argentina from 2003, China from 2008, Germany before 1998, Japan from 2011 and the U.S. 1996, 2003, 2009, 2012 and 2013. A full table of data availability is available upon request. Country-industry contributions are weighted based on average proportions of current price value added during the period.

We subsequently group manufacturing industries using the EUKLEMS categorization. MCons are final consumption goods – ISCO 15-19, 32, 34, 36-37; MInter denotes intermediate goods – ISCO 20-28; ELECOM refers to electronics and communication or ICT equipment, considered high-tech investment goods – ISCO 30, 31, 33, and MInvest signifies other investment goods – ISCO 29, 35 (see Table 3). The country groups are the same as in the 1-digit analysis. The industry categorization is imperfect because in some cases, the same product may be used for consumption or for investment purposes. Bearing this in mind, we have reclassified the industries ISCO 32 and 34 from their original categorisation of investment to consumption (as shown in Table 5).

Table 5 Average annual real output labour productivity growth (%), 2-digit ISIC, 1991-2013, 130 countries

Category	ISIC	Industry	Industrial-ized Economies	Emerging Industrial Economies	Other Developing Economies	Least Developed Countries	Total
MCons	15	Food and beverages	1.13	2.62	1.40	3.23	1.53
MCons	16	Tobacco products	0.43	6.49	5.84	5.24	3.81
MCons	17	Textiles	2.00	4.70	5.80	-8.31	3.25
MCons	18	Wearing apparel, fur	0.06	4.01	2.55	21.30	1.85
MCons	19	Leather, leather products and footwear	-0.59	2.34	0.76	4.50	0.52
MInter	20	Wood products (excl. furniture)	0.92	3.48	4.95	-2.50	1.37
MInter	21	Paper and paper products	2.28	5.50	4.03	-1.20	3.00
MInter	22	Printing and publishing	5.11	2.96	2.70	-5.70	4.86
MInter	23	Coke, refined petroleum products, nuclear fuel	4.15	0.83	0.04	9.17	2.68
MInter	24	Chemicals and chemical products	2.38	4.93	3.81	7.75	3.04
MInter	25	Rubber and plastics products	0.66	3.98	1.68	-11.34	1.30
MInter	26	Non-metallic mineral products	0.78	5.89	4.50	-3.69	2.32

MInter	27	Basic metals	1.05	7.42	4.99	-28.36	3.52
MInter	28	Fabricated metal products	0.81	5.21	12.75		1.49
MInvest	29	Machinery and equipment n.e.c.	1.11	7.47	7.12	-14.51	2.24
ELECOM	30	Office, accounting and computing machinery	1.34	23.53	-0.70		4.13
ELECOM	31	Electrical machinery and apparatus	1.69	9.16	3.78	-0.16	3.83
MCons	32	Radio, television and communication equipment	9.01	13.22	14.12		9.67
ELECOM	33	Medical, precision and optical instruments	6.08	9.88	-0.81		6.41
MCons	34	Motor vehicles, trailers, semi-trailers	1.75	6.27	3.43	-11.06	2.63
MInvest	35	Other transport equipment	5.13	9.59	11.94	-25.27	5.59
MCons	36	Furniture; manufacturing n.e.c.	2.18	4.12	0.69	3.40	2.49
MCons	37	Recycling	-0.33	14.36	-21.06		4.68
Total	15-37	Manufacturing	2.16	5.50	3.60	2.25	2.96

Source: Authors' elaboration based on the INDSTAT2 ISIC, Rev. 3. database (UNIDO, 2016).

The two-digit data reveals that output labour productivity growth in manufacturing was greatest in emerging industrial economies. This is consistent with the one-digit value added data for 1990-2012 (Table 1c). Where this analysis differs with that of the one-digit value added data is that productivity growth in other developing economies increased more quickly than for industrialized economies. This may be attributable to the fact that it is output- rather than value added-based, with more value added realized in industrialized economies. It should also be noted that the availability of data for least developing countries is most varied, with some countries showing a very low number of industry-year entries. Hence, we are cautious regarding the quality of available data, as certain industries and groups of industries had very high annual increases in negative productivity.

Table 6 Average annual real output of labour productivity growth (%), 2-digit ISIC, 1991-2013, 130 countries

Manufacturing Category	Industrialized Economies	Emerging Industrial Economies	Other Developing Economies	Least Developed Countries	Total
ELECOM	3.00	10.77	3.58	-0.16	4.59
MInvest	2.10	7.79	7.53	-16.32	3.02
MInter	1.94	4.99	3.78	-0.45	2.69
MCons	2.29	4.70	2.95	3.40	2.93
Total	2.16	5.50	3.60	2.25	2.96

Source: Authors' elaboration based on the INDSTAT2 ISIC, Rev. 3. database (UNIDO, 2016).

The industry group analysis indicates that productivity growth in consumption goods is generally lower than that in electrical and communication equipment. It is also lower than the productivity growth in other investment goods and intermediate goods in emerging industrial and other developing countries, although this is not the case for industrialized economies. The latter result is heavily influenced by productivity growth in industry 32 'radio, television and communication equipment'. Recall that this industry can either be categorized as a consumption or investment industry. If categorized as an investment industry, the relative productivity performance of consumption goods in industrialized economies is more similar to that of emerging industrial and other developing economies, and less than that of other industries. The

results for the least developed countries seem unreliable. On the whole, the data indicates a relative weakness in the productivity increases achieved in the manufacture of consumption goods, something which may have consequences for improvements in developing economies' real consumption wages.

3.5 Analysis of price changes in manufacturing at the two-digit industry level

This section analyses price changes in manufacturing industries for the same categories, countries and years as the productivity changes in Section 3.3. Price changes were calculated both as value added and output price indices to determine whether there were any significant differences. This is because output price indices are likely to be closer to how consumers experience price changes. However, if the two sets of indices move closely together, the more readily available value added indices may be used for the analysis in subsequent sections. The preparation of country-industry-year VA price data using the UN (2015) national accounts data involved several steps. First, nominal VA in the current national currency for each country-industry-year was converted into current price US$ using annual exchange rates. This measure of nominal VA was then converted into a VA price index by dividing real VA (constant prices) in 2005 US$.

Table 7a Average annual change in value added price index (%), 2-digit ISIC, 1991-2013, 130 countries

Category	ISIC	Industry	Industrialized Economies	Emerging Industrial Economies	Other Developing Economies	Least Developed Countries	Total
MCons	15	Food and beverages	3.12	4.88	2.58	-1.88	3.56
MCons	16	Tobacco products	2.79	3.03	-3.22	4.42	2.76
MCons	17	Textiles	2.07	3.18	1.33	2.56	2.50
MCons	18	Wearing apparel, fur	4.42	4.05	1.08	-25.68	4.08
MCons	19	Leather, leather products and footwear	6.39	4.60	5.02	10.93	5.71
MInter	20	Wood products (excl. furniture)	2.29	5.07	3.86	32.59	2.76
MInter	21	Paper and paper products	1.04	3.71	1.98	3.24	1.64
MInter	22	Printing and publishing	-2.41	0.69	4.71	3.73	-2.04
MInter	23	Coke, refined petroleum products, nuclear fuel	5.37	8.61	10.38	-7.75	6.86
MInter	24	Chemicals and chemical products	2.56	3.21	4.46	-1.07	2.75
MInter	25	Rubber and plastics products	3.17	3.54	1.59	9.73	3.22
MInter	26	Non-metallic mineral products	3.10	3.31	3.35	2.43	3.17
MInter	27	Basic metals	2.93	4.90	0.52	46.59	3.68

MInter	28	Fabricated metal products	3.53	4.90	-1.78		3.65
MInvest	29	Machinery and equipment n.e.c.	3.75	2.61	-2.72	-3.24	3.52
ELECOM	30	Office, accounting and computing machinery	3.23	5.91	1.11		3.57
ELECOM	31	Electrical machinery and apparatus	2.85	0.70	-0.84	-15.78	2.20
MCons	32	Radio, television and communication equipment	-8.25	-4.05	-9.77		-7.61
ELECOM	33	Medical, precision and optical instruments	0.09	1.90	2.06		0.25
MCons	34	Motor vehicles, trailers, semi-trailers	1.96	2.26	5.78	29.36	2.05
MInvest	35	Other transport equipment	0.08	0.95	-11.62	55.06	0.14
MCons	36	Furniture; manufacturing n.e.c.	3.26	4.35	5.35	-27.85	3.45
MCons	37	Recycling	17.52	3.35	37.91		12.69
Total	15-37	Manufacturing	2.15	3.62	3.07	-0.38	2.51

Source: Authors' elaboration based on the INDSTAT2 ISIC, Rev. 3. database (UNIDO, 2016).

Table 7b **Average annual change in value-added price index (%) by type of manufactured good, 2-digit ISIC, 1991-2013, 130 countries**

Manufacturing category	Industrialized Economies	Emerging Industrial Economies	Other Developing Economies	Least Developed Countries	Total
ELECOM	2.05	1.39	-0.73	-15.78	1.90
MInvest	2.84	2.37	-3.49	6.57	2.74
MInter	2.40	4.34	4.60	5.34	2.89
MCons	1.54	3.39	2.03	-2.26	2.03
Total	2.15	3.62	3.07	-0.38	2.51

Source: Authors' elaboration based on the INDSTAT2 ISIC, Rev. 3. database (UNIDO, 2016).

Table 8a Average annual change in output price index (%), 2-digit ISIC, 1991-2013, 130 countries

Category	ISIC	Industry	Industrialized Economies	Emerging Industrial Economies	Other Developing Economies	Least Developed Countries	Total
MCons	15	Food and beverages	4.06	5.12	3.83	0.29	4.34
MCons	16	Tobacco products	2.79	3.98	1.40	-4.13	3.40
MCons	17	Textiles	2.47	3.48	1.85	7.57	2.87
MCons	18	Wearing apparel, fur	4.90	4.22	0.69	-24.62	4.40
MCons	19	Leather, leather products and footwear	6.30	4.54	4.26	31.37	5.61
MInter	20	Wood products (excl. furniture)	3.10	5.35	5.37	47.36	3.50
MInter	21	Paper and paper products	1.94	3.89	3.03	0.56	2.39
MInter	22	Printing and publishing	-2.27	1.90	3.92	3.95	-1.77
MInter	23	Coke, refined petroleum products, nuclear fuel	10.91	9.87	15.92	-13.62	10.80
MInter	24	Chemicals and chemical products	3.76	3.32	4.40	-2.74	3.66
MInter	25	Rubber and plastics products	4.21	4.20	2.46	19.42	4.19
MInter	26	Non-metallic mineral products	4.59	3.88	2.75	5.57	4.33
MInter	27	Basic metals	6.37	5.34	-1.46	27.09	5.92
MInter	28	Fabricated metal products	4.26	5.00	-0.25		4.31

MInvest	29	Machinery and equipment n.e.c.	4.11	2.90	-1.84	10.24	3.86
ELECOM	30	Office, accounting and computing machinery	-0.47	4.93	4.64		0.25
ELECOM	31	Electrical machinery and apparatus	3.51	1.06	0.97	-17.69	2.77
MCons	32	Radio, television and communication equipment	-8.18	-3.50	-9.30		-7.46
ELECOM	33	Medical, precision and optical instruments	0.18	1.69	4.22		0.32
MCons	34	Motor vehicles, trailers, semi-trailers	2.48	3.51	4.78	11.65	2.70
MInvest	35	Other transport equipment	0.18	1.58	-5.18	48.94	0.31
MCons	36	Furniture; manufacturing n.e.c.	2.89	4.78	4.68	-9.00	3.23
MCons	37	Recycling	15.81	3.55	51.01		11.63
Total	15-37	Manufacturing	2.97	4.07	4.20	-0.63	3.25

Source: Authors' elaboration based on the INDSTAT2 ISIC, Rev. 3. database (UNIDO, 2016).

Table 8b **Average Annual change in the output price index (%) by type of manufactured good, 2-digit ISIC, 1991-2013, 130 countries**

Manufacturing category	Industrialized Economies	Emerging Industrial Economies	Other Developing Economies	Least Developed Countries	Total
ELECOM	1.70	1.55	1.13	-17.69	1.66
MInvest	3.12	2.70	-2.13	17.54	3.02
MInter	3.85	4.80	5.88	4.35	4.11
MCons	1.99	3.90	2.86	-2.05	2.51
Total	2.97	4.07	4.20	-0.63	3.25

Source: Authors' elaboration based on the INDSTAT2 ISIC, Rev. 3. database (UNIDO, 2016).

The patterns observed are largely similar, irrespective of the price index used. Averaged across the manufacturing sector, price increases have been lowest in industrialized economies, with emerging industrial and other developing economies recording the second lowest price increases at similar levels. Given the productivity increases calculated in Tables 5 and 6, with emerging industrial economies performing strongest, this suggests that not all of the productivity increases are being translated into corresponding price decreases in their country of origin. The lower price increases in industrialized economies suggest that these economies are benefitting from productivity increases in other countries, potentially through dispersed global value chains as discussed in Section 2.3. Within manufacturing, output price increases were lowest in electrical and communications equipment, consistent with the productivity increases observed in that industry. On average, output price increases were second lowest in consumption goods, although they varied by country group with consumption goods being higher than investment goods in both emerging industrial and other developing countries, although significantly lower for industrialized economies. In both output and value added price indices, industrialized countries have benefitted from lower increases than other countries.[6] The next section examines the relationship between productivity and price increases using more formal analytical methods.

[6] The fact that the increase in the VA price index is lower than that in the output price index in industrialized economies implies that input prices have been increasing more slowly than output prices, consistent with the argument of Millberg and Winkler (2013) on global value chains, discussed in Section 2.3.

3.6 Relationship between productivity increases and prices at the two-digit industry level

As Sections 3.4 and 3.5 show, our analysis contains three broad categories of manufactured goods: consumption, intermediate and investment goods, which is further divided into ICT, labelled (ELECOM), and other investment goods.

As discussed in Section 2.3, under standard assumptions of competition, there should be a direct effect from productivity increases in the production of consumption goods on reduced prices and increased real consumption wages. However, this depends on the degree of competition in the industry and the extent to which the consumption goods are consumed in the local market. Productivity increases in the production of intermediate goods by definition indicates that the product is part of a longer value chain which may be domestic or global in nature. In this case, increases in the local real consumption wage depend on productivity increases translating into price decreases of intermediate goods (due to competition), which are then passed on further up the chain in the form of price decreases in locally consumed consumption goods.[7]

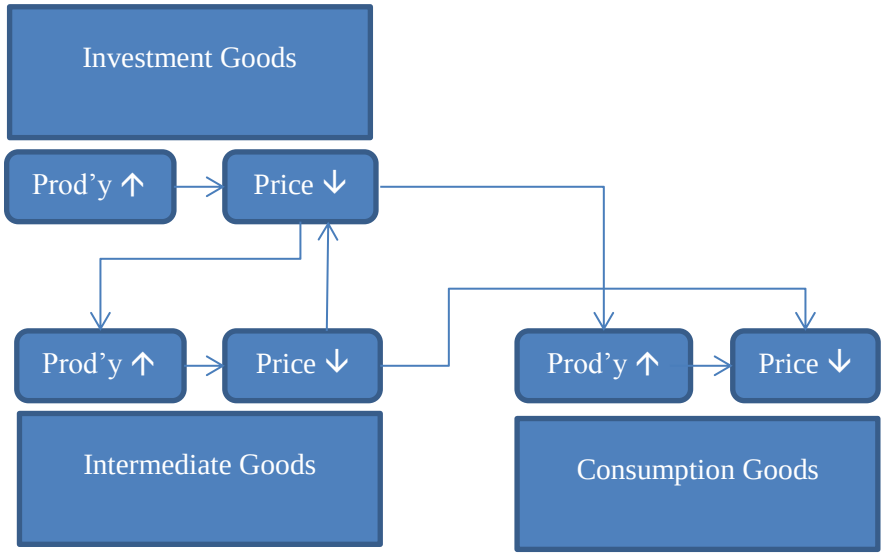
We would expect companies' purchase of investment goods to increase labour productivity in the production of both intermediate and consumption goods. Hence, if productivity increases in the production of investment goods results in price decreases, which in turn stimulate investment in those goods by intermediate and consumption goods industries, it might be expected that productivity in those industries will increase. The extent to which this type of manufacturing exists in developing countries and again whether it is intended for domestic or foreign markets has an impact on the effect. Another factor to consider is that the ISIC industry definitions at the two-digit level may not sufficiently distinguish whether an investment product is a component within a longer value chain or a final investment product. If an investment product is in fact a component within a longer value chain, the relationship between local productivity increases, price decreases and spillover productivity effects in intermediate and consumption goods becomes further removed.

The stylized potential inter-relationships between productivity and price changes of the three types of goods is illustrated in Figure 2. The linkages between productivity and price changes within each type of good depend on the degree of competition; the linkages between price decreases in investment goods and productivity increases in intermediate and consumption goods depend on those price decreases stimulating investment in those sectors, while linkages

[7] Clearly, price decreases in intermediate goods may also reduce the price of investment goods.

between price decreases in intermediate goods and price decreases in other categories depend on categories using those specific intermediate goods in the production process.

Figure 2 Potential inter-relationship between productivity and price changes of different categories of manufactured goods



The most accurate way to analyse inter-relationships between industries and ultimately the price of consumption goods in any region is to use input-output tables that specify the linkages between industries at a detailed level. However, this does not expose international linkages in global value chains and hence, a case study analysis of particular value chains is likely to be more accurate than a broad statistical analysis. In the absence of a detailed understanding of industry connections within global value chains, we can explore the relationships between productivity and price changes of broad types of industry *within* each country. The results can then be presented for each individual country group. Hence, we have produced a system of five equations that capture the potential relationships indicated in Figure 2. These trace back from our main dependent variable, the price index of consumption goods, to price and productivity changes in intermediate and investment goods. The equations are as follows:

1. Changes in the price index of consumption goods are attributable to changes in the labour productivity of consumption goods and changes in the price index of intermediate goods;
2. Changes in the labour productivity of consumption goods are attributable to changes in the price index of investment goods;

3. Changes in the price index of intermediate goods are attributable to changes in the labour productivity of intermediate goods;
4. Changes in the labour productivity of intermediate goods are attributable to changes in the price index of investment goods;
5. Changes in the price index of investment goods are attributable to changes in the labour productivity of investment goods and changes in the price index of intermediate goods.

$$\mathrm{dlnVAP}^{cons}{}_{\mathrm{cit}} = \beta_0 + \beta_1 \mathrm{dlnLP}^{cons}{}_{\mathrm{cit}} + \beta_2 \mathrm{dlnVAP}^{inter}{}_{\mathrm{ct}} + \eta_{\mathrm{c}} + \eta_{\mathrm{i}} + \eta_{\mathrm{t}} + \eta_{\mathrm{cit}} \quad (1)$$

$$\mathrm{dlnLP}^{cons}{}_{\mathrm{cit}} = \beta_0 + \beta_1 \mathrm{dlnVAP}^{invest}{}_{\mathrm{ct}} + \eta_{\mathrm{c}} + \eta_{\mathrm{i}} + \eta_{\mathrm{t}} + \eta_{\mathrm{cit}} \quad (2)$$

$$\mathrm{dlnVAP}^{inter}{}_{\mathrm{cit}} = \beta_0 + \beta_1 \mathrm{dlnLP}^{inter}{}_{\mathrm{cit}} + \eta_{\mathrm{c}} + \eta_{\mathrm{i}} + \eta_{\mathrm{t}} + \eta_{\mathrm{cit}} \quad (3)$$

$$\mathrm{dlnLP}^{inter}{}_{\mathrm{cit}} = \beta_0 + \beta_1 \mathrm{dlnVAP}^{invest}{}_{\mathrm{ct}} + \eta_{\mathrm{c}} + \eta_{\mathrm{i}} + \eta_{\mathrm{t}} + \eta_{\mathrm{cit}} \quad (4)$$

$$\mathrm{dlnVAP}^{invest}{}_{\mathrm{cit}} = \beta_0 + \beta_1 \mathrm{dlnLP}^{invest}{}_{\mathrm{cit}} + \beta_2 \mathrm{dlnVAP}^{inter}{}_{\mathrm{ct}} + \eta_{\mathrm{c}} + \eta_{\mathrm{i}} + \eta_{\mathrm{t}} + \eta_{\mathrm{cit}} \quad (5)$$

The variables have been constructed using UNIDO, 2016 as follows:

dlnLP – Change in the log of output labour productivity calculated as the Index Number of Industrial Production (IIP)/no. employees. We use IIP as a proxy for the volume of output because we do not have price indices by which to deflate the current price measures of value added into a constant price real measure.

dlnVAP – Change in ln of the value added price index calculated as the value added in current US$/IIP

The superscripts *cons*, *inter* and *invest* refer to *consumption*, *intermediate* and *investment* goods groups of industries, respectively. The subscripts *c,i,t* denote country, industry and year. Where the number of cases does not match between dependent and independent variables in the same equation, because there are different numbers of industries in each industry group, a multi-level method is used. This provides separate country, industry and time cases for the dependent variable, represented by the subscript $_{\mathrm{cit}}$, but calculates country averages for the industry group of the independent variable, represented by the subscript $_{\mathrm{ct}}$. η_{c}, η_{i} and η_{t} are country, industry and year dummies to control for unobserved heterogeneity and time dynamics, and η_{cit} is the stochastic error term. The results are presented in Section 3.7

These separate regressions provide a simple and direct impression of the relationship between variables in the same time period, but assume that the independent variables are exogenous.

Although there is solid theoretical rationale for the direction of causation to be that proposed by the equations, there is a possibility of reverse causation and other potential endogeneity problems. One possible way to overcome this is to use lags of the independent variables as instruments of the current period. However, we found lagged changes in labour productivity to be strongly negatively correlated with changes in the subsequent period. This likely indicates that increases in labour productivity are relatively short-lived rather than continuous, and that lagged changes are not good instruments for subsequent changes. To test whether the effect of current period independent variables are robust, we ran different specifications of the regression equations above. The first covered the current period independent variables (results are shown in Section 3.7), the second covered the current period plus three separate previous period lags of each independent variable (results available in Appendix 1). The results are comparable, with the current period independent variables having the strongest statistically significant effect, even when lagged variables were present. Some of the lagged independent variables had statistical significance but the effects were minor in comparison to the current period effects.

While the regression analysis in Section 3.7 and a comparison with models using lagged independent variables (Appendix 1) allows us to be fairly confident of the relationships identified between variables, a further test that controls for potential endogeneity problems is used to treat Equations (1)-(5) as a simultaneous structural equation model (SEM). SEM allows us to simultaneously estimate the relationship between changes in real productivity and price within different industry groups while modelling co-variations amongst them. Modelling changes of real productivity and price mechanisms within and across industries simultaneously is important in light of our hypothesis that the production of consumption goods is interrelated with the production of intermediate and investment goods (Figure 2). The results for each of the five equations are provided in Appendix 2. Despite the reduced number of cases, the results are similar to those for the separate regressions in Section 3.7 and Appendix 1. This gives us some confidence in their robustness.

3.7 Two-digit industry regression results, same period independent variables, 2-digit ISIC, 1991-2013, 130 countries

Table 9a **Change in the price index of consumption goods regressed upon changes in the labour productivity of consumption goods and in the price index of intermediate goods**

$dlnVAP^{cons}_{cit}$	All	Industrialized Economies	Emerging Industrial Economies	Other Developing Economies	Least Developed Countries
$dlnLP^{cons}_{cit}$	-0.342***	-0.322***	-0.358***	-0.428***	-0.339***
	(0.012)	(0.019)	(0.019)	(0.040)	(0.090)
$dlnVAP^{inter}_{ct}$	0.538***	0.559***	0.548***	0.344***	0.175
	(0.016)	(0.027)	(0.027)	(0.026)	(0.230)
country dummy	yes	yes	yes	yes	yes
year dummy	yes	yes	yes	yes	yes
industry dummy	yes	yes	yes	yes	yes
R-squared	0.377	0.395	0.406	0.297	0.566
N	6208	2944	1929	1251	84

These results are in line with our expectations. The change in the VA price index of consumption goods is reduced by an increase in the labour productivity of those same goods and moves in line with an increase/decrease in the price index of intermediate goods. This holds across all country groups, the exception being that the intermediate goods effect is not statistically significant for the least developed countries group. This is likely attributable to the fact that the sample size is an order of magnitude smaller for this group of countries due to data availability. It may also be that the nature of production in these countries is less developed, with weaker internal linkages between intermediate and consumption goods industries. It should be noted that we have not matched specific intermediate and consumption goods industries in this analysis, the change in the price of intermediate goods are country averages across the intermediate goods industries for each year. However, many of the intermediate goods industries provide inputs to multiple downstream industries, so despite the lack of input-output matching, we still witness a strong and statistically significant general effect.

Table 9b **Change in the labour productivity of consumption goods regressed upon changes in the price index of investment goods**

$dlnLP^{cons}_{cit}$	All	Industrialized Economies	Emerging Industrial Economies	Other Developing Economies	Least Developed Countries
$dlnVAP^{invest}_{ct}$	-0.170***	-0.164***	-0.282***	-0.027*	0.567**
	(0.012)	(0.018)	(0.026)	(0.016)	(0.218)
country dummy	yes	yes	yes	yes	yes
year dummy	yes	yes	yes	yes	yes
industry dummy	yes	yes	yes	yes	yes
R-squared	0.218	0.220	0.267	0.069	0.582
N	5912	2844	1922	1093	53

These results indicate that in industrialized and emerging industrial economies, a reduction in the value-added price index of investment goods increases the labour productivity of consumption goods. The results are the same for other developing economies, although the effect is small and not as statistically significant. The small sample size for the least developed economies likely impedes our ability to see the effect for these countries. We hypothesize that reductions in the prices of investment goods stimulates investment in those goods by producers of consumption goods in industrialized and emerging economies, but to a much lesser extent in other developing economies. In the industries where the investment occurs, the rate of change in labour productivity increases. As with Table 9a, the investment goods' price data are country-year averages.

Table 9c **Change in the price index of intermediate goods regressed upon changes in the labour productivity of intermediate goods**

$dlnVAP^{inter}_{cit}$	All	Industrialized Economies	Emerging Industrial Economies	Other Developing Economies	Least Developed Countries
$dlnLP^{inter}_{cit}$	-0.607***	-0.587***	-0.642***	-0.678***	-0.522***
	(0.014)	(0.020)	(0.025)	(0.039)	(0.155)
country dummy	yes	yes	yes	yes	yes
year dummy	yes	yes	yes	yes	yes
industry dummy	yes	yes	yes	yes	yes
R-squared	0.311	0.316	0.391	0.321	0.215
N	8078	3914	2389	1637	138

The results are as expected, with the value added price index of intermediate goods decreasing with an increase in the labour productivity of the same goods in the same country and year. The effect is strong and statistically significant across all country groups.

Table 9d **Change in the labour productivity of intermediate goods regressed upon changes in the price index of investment goods**

$dlnLP^{inter}_{cit}$	All	Industrialized Economies	Emerging Industrial Economies	Other Developing Economies	Least Developed Countries
$dlnVAP^{invest}_{ct}$	-0.038***	0.035**	-0.210***	-0.017	-0.584***
	(0.012)	(0.018)	(0.026)	(0.016)	(0.200)
country dummy	yes	yes	yes	yes	yes
year dummy	yes	yes	yes	yes	yes
industry dummy	yes	yes	yes	yes	yes
R-squared	0.124	0.086	0.233	0.205	0.400
N	7628	3773	2352	1415	88

Change in the labour productivity of intermediate goods moves inversely with change in the value added price index of investment goods. However, the effect is only statistically significant for emerging industrial economies and least developed economies, the latter, as mentioned, having a small sample size and hence unlikely to be reliable. Explaining the pattern of results across countries requires further research. The effect for emerging industrial economies may be attributable to a concentration of the production of intermediate goods in those countries. The weak response of labour productivity in intermediate goods production to price changes in investment goods in industrialized countries may be attributable to an absence of these industries or relatively slow technological change within them, with industrialized countries already having invested in long-lived capital equipment. The weak effect in other developed economies may be due to limited intermediate production or to restricted access to capital, thus hampering investment. We witnessed a similar effect in Table 9b with the labour productivity of consumption goods produced in other developing economies responding weakly to changes in the price index of investment goods produced there.

Table 9e **Change in the price index of investment goods regressed upon changes in the labour productivity of investment goods and in the price index of intermediate goods**

$dlnVAP^{invest}_{cit}$	All	Industrialized Economies	Emerging Industrial Economies	Other Developing Economies	Least Developed Countries
$dlnLP^{invest}_{cit}$	-0.744***	-0.928***	-0.294***	-0.965***	-1.109**
	(0.012)	(0.016)	(0.018)	(0.039)	(0.452)
$dlnVAP^{inter}_{ct}$	0.374***	0.309***	0.516***	0.314***	-3.145
	(0.029)	(0.039)	(0.050)	(0.057)	(15.271)
country dummy	yes	yes	yes	yes	yes
year dummy	yes	yes	yes	yes	yes
industry dummy	yes	yes	yes	yes	yes
R-squared	0.563	0.688	0.348	0.724	0.783
N	3343	1807	1023	486	27

These results are largely as expected. Increasing the labour productivity of investment goods universally reduces the value added price index for those goods in the same country, industry and year. Increasing or reducing the value added price index of intermediate goods increases or reduces the value added price index of investment goods, respectively. This is strong and statistically significant for all country groups, except the least developed economies where the sample size is too small to be reliable.

4 Conclusions

Our analysis shows that labour productivity increases were greatest in agriculture and manufacturing, and that price increases were lowest in those sectors between 1970 and 2012-13. This provides some initial support for a competitive theoretical framework that links productivity increases to falling prices within industries. Our regression analysis also provides some support for this framework when examining all industries and manufacturing at a high level of industry aggregation. However, the results for emerging industrial economies are not statistically significant for manufacturing (Table 4), indicating possible geographic diversity and additional complexity in the application of this framework.

While industrialized economies had the strongest productivity growth in the period 1970-1990, emerging industrialized economies took the lead in 1991–2012 and other developing economies also significantly increased their productivity in most sectors during this period. Despite this, price increases remained lowest in industrialized economies, potentially lending support to the argument that production organized in global value chains disrupts the automatic transmission of productivity increases to price decreases in the location of production and favours lead firms, largely headquartered in industrialized economies, over suppliers in less developed countries (Milberg & Winkler, 2013).

Within manufacturing, productivity growth in the production of consumption goods has generally been lower than that in the production of ICT, other investment and intermediary goods, although this depends on the categorization of certain industries, particularly in industrialized economies. However, while price increases have been lowest in ICT goods, they have also been low for consumption goods in industrialized economies, while remaining higher than those for investment goods in emerging industrial and other developing economies. This may be a further indication of the relative pricing power of lead firms located in industrialized economies within global production networks.

Despite the inter-country relationships in global production, productivity increases in investment and intermediate goods may still contribute to lower prices (or lower price increases) in consumption goods and hence, rising real consumption wages through the interconnection of these types of goods in production processes (Figure 2). However, the localized impact of such productivity increases depends on the extent to which these products are integrated into local production networks serving local consumers. The final part of this paper explored this aspect, using a number of different econometric techniques.

Consistent with competitive theory, we found that productivity increases within consumption, investment and intermediate goods tended to reduce the rate of change of their prices, irrespective of country group. This suggests that productivity increases within countries are generally passed on as price decreases. The universal effect that a negative change in the price of intermediate goods has a corresponding negative effect on change in the price of consumption and investment goods was also identified, presumably through their role as an input, hence increasing real consumption wages. However, a reduction in the rate of change of the price of investment goods had a corresponding negative effect upon change in the labour productivity (and ultimately, the price) of consumption goods in industrialized and emerging industrial economies only. This suggests that other developing economies are unable to benefit from relatively cheaper investment goods produced locally, either because these goods are unsuitable for local production or potentially because credit to invest in them is limited. A similar result was also observed regarding the impact of changes in the price of investment goods on the labour productivity (and ultimately, the price) of intermediate goods. Further research is required to better understand the nature of these limitations. Our research was also limited to general statistical analyses and case studies of specific value chains and the use of input-output tables are potential future avenues of research, which could further enhance our understanding of the impact of domestic productivity increases upon real consumption wages.

Appendix 1 Two-digit industry regression results, including lagged independent variables, 2-digit ISIC, 1991-2013, 130 countries

Table A.1.1 Change in the price index of consumption goods regressed upon changes in the labour productivity of consumption goods and in the price index of intermediate goods

$dlnVAP^{cons}_{cit}$	**All**	**Industrialized Economies**	**Emerging Industrial Economies**	**Other Developing Economies**	**Least Developed Countries**
$dlnLP^{cons}_{cit}$	-0.407***	-0.390***	-0.440***	-0.594***	-0.106
	(0.014)	(0.020)	(0.024)	(0.068)	(0.279)
$dlnLP^{cons}_{ci(t-1)}$	-0.036**	-0.052**	-0.025	-0.076	0.152
	(0.014)	(0.020)	(0.023)	(0.064)	(0.267)
$dlnLP^{cons}_{ci(t-2)}$	-0.045***	-0.052**	-0.034	0.018	-0.182
	(0.014)	(0.021)	(0.023)	(0.058)	(0.334)
$dlnLP^{cons}_{ci(t-3)}$	0.034**	0.042**	0.054**	-0.153***	0.765***
	(0.014)	(0.021)	(0.022)	(0.051)	(0.261)
$dlnVAP^{inter}_{ct}$	0.540***	0.560***	0.553***	0.440***	0.085
	(0.017)	(0.028)	(0.033)	(0.036)	(0.513)
$dlnVAP^{inter}_{c(t-1)}$	0.075***	0.050*	0.144***	0.017	0.243
	(0.017)	(0.028)	(0.034)	(0.042)	(0.709)
$dlnVAP^{inter}_{c(t-2)}$	0.062***	0.035	0.183***	0.023	0.515
	(0.018)	(0.030)	(0.035)	(0.041)	(1.305)
$dlnVAP^{inter}_{c(t-3)}$	0.048***	0.011	0.167***	-0.075**	0.224
	(0.018)	(0.032)	(0.034)	(0.034)	(1.009)
country dummy	yes	yes	yes	yes	yes
year dummy	yes	yes	yes	yes	yes
industry dummy	yes	yes	yes	yes	yes
R-squared	0.403	0.399	0.454	0.400	0.418
N	4226	2040	1387	757	42

Table A1.2 Change in the labour productivity of consumption goods regressed upon changes in the price index of investment goods

$dlnLP^{cons}_{cit}$	**All**	**Industrialized Economies**	**Emerging Industrial Economies**	**Other Developing Economies**	**Least Developed Countries**
$dlnVAP^{invest}_{ct}$	-0.167***	-0.212***	-0.100**	-0.022	0.124
	(0.016)	(0.021)	(0.040)	(0.020)	(0.071)
$dlnVAP^{invest}_{c(t-1)}$	0.011	0.006	0.059*	-0.094***	0.340***
	(0.015)	(0.020)	(0.035)	(0.020)	(0.061)
$dlnVAP^{invest}_{c(t-2)}$	0.053***	0.051**	0.080**	0.012	0.494***
	(0.015)	(0.021)	(0.033)	(0.018)	(0.067)
$dlnVAP^{invest}_{c(t-3)}$	-0.035**	-0.092***	0.026	0.003	0.856***
	(0.014)	(0.020)	(0.034)	(0.016)	(0.068)
country dummy	yes	yes	yes	yes	yes
year dummy	yes	yes	yes	yes	yes
industry dummy	yes	yes	yes	yes	yes
R-squared	0.223	0.248	0.288	0.117	0.892
N	4124	2014	1404	678	28

Table A.1.3 Change in the price index of intermediate goods regressed upon changes in the labour productivity of intermediate goods

$dlnVAP^{inter}_{cit}$	**All**	**Industrialized Economies**	**Emerging Industrial Economies**	**Other Developing Economies**	**Least Developed Countries**
$dlnLP^{inter}_{cit}$	-0.651***	-0.673***	-0.667***	-0.724***	-0.123
	(0.016)	(0.021)	(0.032)	(0.049)	(0.253)
$dlnLP^{inter}_{ci(t-1)}$	-0.049***	-0.198***	0.161***	0.209***	0.335
	(0.016)	(0.022)	(0.030)	(0.050)	(0.246)
$dlnLP^{inter}_{ci(t-2)}$	0.004	-0.034	0.016	0.029	-0.028
	(0.016)	(0.022)	(0.029)	(0.056)	(0.245)
$dlnLP^{inter}_{ci(t-3)}$	-0.012	0.036	-0.041	-0.505***	0.178
	(0.017)	(0.023)	(0.029)	(0.051)	(0.261)
country dummy	yes	yes	yes	yes	yes
year dummy	yes	yes	yes	yes	yes
industry dummy	yes	yes	yes	yes	yes
R-squared	0.326	0.380	0.344	0.485	0.180
N	5671	2831	1739	1022	79

Table A.1.4 Change in the labour productivity of intermediate goods regressed upon changes in the price index of investment goods

$dlnLP^{inter}_{cit}$	**All**	**Industrialized Economies**	**Emerging Industrial Economies**	**Other Developing Economies**	**Least Developed Countries**
$dlnVAP^{invest}_{ct}$	-0.027*	0.013	-0.029	0.012	0.471***
	(0.016)	(0.023)	(0.037)	(0.024)	(0.154)
$dlnVAP^{invest}_{c(t-1)}$	0.034**	0.080***	-0.075**	-0.006	-0.099
	(0.015)	(0.022)	(0.033)	(0.022)	(0.133)
$dlnVAP^{invest}_{c(t-2)}$	0.062***	0.061***	0.146***	0.036*	0.657***
	(0.015)	(0.023)	(0.032)	(0.020)	(0.144)
$dlnVAP^{invest}_{c(t-3)}$	-0.096***	-0.159***	0.015	0.038*	0.394**
	(0.014)	(0.021)	(0.033)	(0.020)	(0.146)
country dummy	yes	yes	yes	yes	yes
year dummy	yes	yes	yes	yes	yes
industry dummy	yes	yes	yes	yes	yes
R-squared	0.184	0.123	0.350	0.331	0.380
N	5404	2734	1727	889	54

Table A.1.5 Change in the price index of investment goods regressed upon changes in the labour productivity of investment goods and in the price index of intermediate goods

$dlnVAP^{invest}_{cit}$	**All**	**Industrialized Economies**	**Emerging Industrial Economies**	**Other Developing Economies**	**Least Developed Countries**
$dlnLP^{invest}_{cit}$	-0.793***	-0.965***	-0.269***	-0.991***	-0.816
	(0.014)	(0.017)	(0.023)	(0.075)	(.)
$dlnLP^{invest}_{ci(t-1)}$	-0.101***	-0.080***	-0.055**	0.081	0.449
	(0.014)	(0.017)	(0.023)	(0.064)	(.)
$dlnLP^{invest}_{ci(t-2)}$	-0.022	-0.025	-0.045**	0.004	0.052
	(0.014)	(0.017)	(0.023)	(0.064)	(.)
$dlnLP^{invest}_{ci(t-3)}$	0.010	0.002	0.006	-0.057	0.080
	(0.013)	(0.016)	(0.020)	(0.051)	(.)
$dlnVAP^{inter}_{ct}$	0.354***	0.264***	0.420***	0.343***	-1.538
	(0.035)	(0.046)	(0.063)	(0.078)	(.)
$dlnVAP^{inter}_{c(t-1)}$	0.053	0.123***	0.078	0.171**	-1.877
	(0.034)	(0.045)	(0.061)	(0.080)	(.)
$dlnVAP^{inter}_{c(t-2)}$	0.058*	0.033	0.173***	0.017	-1.461
	(0.034)	(0.047)	(0.063)	(0.076)	(.)
$dlnVAP^{inter}_{c(t-3)}$	0.028	0.011	0.163***	-0.140**	-0.534
	(0.035)	(0.050)	(0.060)	(0.068)	(.)
country dummy	yes	yes	yes	yes	yes
year dummy	yes	yes	yes	yes	yes
industry dummy	yes	yes	yes	yes	yes
R-squared	0.614	0.742	0.332	0.723	.
N	2295	1275	714	297	9

Appendix 2 SEM results

This technique is based on the five equations presented in Section 3.6, including lags of the independent variables. To simplify the model, the 1963–2014 year dummies have been aggregated into three dummies for the years<=1990, 1990<years<=2005 and 2005<years<=2014. For this technique, the number of cases for dependent and independent variables need to match across all equations and hence, country-year averages for each of the three industry groups are calculated. This significantly reduces the total number of cases from the multi-level method used in Section 3.7. Due to the reduction in cases, other developing and least developed economies were merged. Since our data may not be normally distributed, maximum likelihood methods have also been used (Boomsma and Hoogland, 2001; Distefano, 2002).

Table A.2.1 Change in the price index of consumption goods regressed upon changes in the labour productivity of consumption goods and in the price index of intermediate goods

$dlnVAP^{cons}_{ct}$	All	**Industrialized Economies**	**Emerging Industrial Economies**	**Other and Least Developed Economies**
$dlnLP^{cons}_{ct}$	-0.323	-0.399***	-0.308***	-0.152
	0.310	***0.040***	***0.044***	***0.628***
$dlnLP^{cons}_{c(t-1)}$	-0.003	-0.070*	0.064	-0.247
	0.311	***0.040***	***0.043***	***0.603***
$dlnLP^{cons}_{c(t-2)}$	-0.138	-0.216***	-0.091**	-0.123
	0.326	***0.045***	***0.043***	***0.571***
$dlnLP^{cons}_{c(t-3)}$	0.101	0.074*	0.101***	-0.315
	0.328	***0.046***	***0.043***	***0.503***
$dlnVAP^{inter}_{ct}$	0.559***	0.579***	0.516***	0.584***
	0.209	***0.027***	***0.036***	***0.156***
$dlnVAP^{inter}_{c(t-1)}$	0.054	0.023	0.094***	0.063
	0.204	***0.026***	***0.034***	***0.158***
$dlnVAP^{inter}_{c(t-2)}$	0.032	0.001	0.144***	0.007
	0.203	***0.025***	***0.037***	***0.156***
$dlnVAP^{inter}_{c(t-3)}$	0.038	0.032	0.172***	-0.111
	0.207	***0.026***	***0.040***	***0.140***
country dummy	yes	yes	yes	yes
decade dummy	yes	yes	yes	yes
N	681	333	218	130

Table A.2.2 Change in the labour productivity of consumption goods regressed upon changes in the price index of investment goods

$dlnLP^{cons}_{ct}$	All	**Industrialized Economies**	**Emerging Industrial Economies**	**Other and Least Developed Economies**
$dlnVAP^{invest}_{ct}$	-0.175	-0.216***	-0.189***	-0.045
	0.247	***0.026***	***0.069***	***0.066***
$dlnVAP^{invest}_{c(t-1)}$	-0.015	-0.004	0.012	-0.027
	0.230	***0.024***	***0.065***	***0.063***
$dlnVAP^{invest}_{c(t-2)}$	0.036	0.034	0.098	0.003
	0.236	***0.026***	***0.065***	***0.061***
$dlnVAP^{invest}_{c(t-3)}$	0.025	0.000	0.139**	0.025
	0.221	***0.023***	***0.065***	***0.057***
country dummy	yes	yes	yes	yes
decade dummy	yes	yes	yes	yes
N	681	333	218	130

Table A.2.3 Change in the price index of intermediate goods regressed upon changes in the labour productivity of intermediate goods

$dlnVAP^{inter}_{ct}$	All	**Industrialized Economies**	**Emerging Industrial Economies**	**Other and Least Developed Economies**
$dlnLP^{inter}_{ct}$	-0.337	-0.359***	-0.272***	-4.348
	0.574	***0.067***	***0.107***	***3.089***
$dlnLP^{inter}_{c(t-1)}$	-0.084	-0.299***	0.059	-0.468
	0.516	***0.063***	***0.092***	***1.362***
$dlnLP^{inter}_{c(t-2)}$	-0.138	-0.174***	-0.172	-0.754
	0.534	***0.067***	***0.089***	***1.240***
$dlnLP^{inter}_{c(t-3)}$	-0.005	-0.003	0.003	-1.406
	0.555	***0.072***	***0.092***	***1.356***
country dummy	yes	yes	yes	yes
decade dummy	yes	yes	yes	yes
N	681	333	218	130

Table A.2.4 Change in the labour productivity of intermediate goods regressed upon changes in the price index of investment goods

$dlnLP^{inter}_{ct}$	All	**Industrialized Economies**	**Emerging Industrial Economies**	**Other and Least Developed Economies**
$dlnVAP^{invest}_{ct}$	0.014	0.055*	-0.083	1.667
	0.321	***0.034***	***0.087***	***2.972***
$dlnVAP^{invest}_{c(t-1)}$	0.000	0.068***	-0.134**	0.121
	0.259	***0.028***	***0.067***	***0.505***
$dlnVAP^{invest}_{c(t-2)}$	0.061	0.069**	0.155***	0.164
	0.265	***0.030***	***0.066***	***0.518***
$dlnVAP^{invest}_{c(t-3)}$	-0.020	-0.066***	0.107*	0.418
	0.249	***0.027***	***0.067***	***0.756***
country dummy	yes	yes	yes	yes
industry dummy	yes	yes	yes	yes
N	681	333	218	130

Table A.2.5 Change in the price index of investment goods regressed upon changes in the labour productivity of investment goods and in the price index of intermediate goods

$dlnVAP^{invest}_{ct}$	**All**	**Industrialized Economies**	**Emerging Industrial Economies**	**Other and Least Developed Economies**
$dlnLP^{invest}_{ct}$	-0.541**	-0.729***	-0.196***	0.254
	0.246	***0.026***	***0.039***	***0.578***
$dlnLP^{invest}_{c(t-1)}$	-0.031	-0.036	-0.033	-0.252
	0.248	***0.026***	***0.038***	***0.478***
$dlnLP^{invest}_{c(t-2)}$	-0.023	-0.052*	-0.007	-0.104
	0.258	***0.029***	***0.038***	***0.394***
$dlnLP^{invest}_{c(t-3)}$	0.103	0.058**	0.094***	-0.155
	0.243	***0.027***	***0.037***	***0.335***
$dlnVAP^{inter}_{ct}$	0.484*	0.518***	0.431***	1.337***
	0.286	***0.036***	***0.044***	***0.384***
$dlnVAP^{inter}_{c(t-1)}$	0.045	0.038	0.126***	0.309
	0.273	***0.034***	***0.041***	***0.275***
$dlnVAP^{inter}_{c(t-2)}$	0.034	0.015	0.130***	0.094
	0.274	***0.034***	***0.045***	***0.247***
$dlnVAP^{inter}_{c(t-3)}$	0.075	0.116***	0.193***	-0.227
	0.279	***0.033***	***0.047***	***0.216***
country dummy	yes	yes	yes	yes
industry dummy	yes	yes	yes	yes
N	681	333	218	130

References

Alchian, 1987, Rent Theory, in: J. Eatwell, M. Milgate and P. Newman, eds., The New Palgrave: a dictionary of economics (Macmillan, London).

Appelbaum, E. and R. Schettkat, 1995, Employment and productivity in industrialised economies. *International Labour Review* 134, 605-23.

Bain, J.S. (1956) *Barriers to new competition: their character and consequences in manufacturing industries*, Oxford, Oxford University Press.

Baldwin, R. (2009) 'The Great Trade Collapse: What Caused it and What Does it Mean?' in R. Baldwin (Ed.) *The Great Trade Collapse: Causes, Consequences and Prospects*, www.vox.eu.org.

Baumol, W.J. (1967) 'Macroeconomics of Unbalanced Growth: The Anatomy of Urban Crisis', *The American Economic Review*, **57** (3), 415-26.

Baumol, W.J., Blackman, A.B. and Wolff, E.N. (1985) 'Unbalanced Growth Revisited: Asymptotic Stagnancy and New Evidence', *The American Economic Review* **75** (4), 806-17.

Bhatia, U.S. (2013) 'The globalization of supply chains: policy challenges for developing countries' in Elms, D.K. and Low, P. (Eds.) (2013) *Global Value Chains in a Changing World* (WTO Publications, Geneva)

Boomsma, A. and Hoogland, J. J. (2001) 'The robustness of LISREL modelling revisited', in R. Cudeck, S. du Toit and D. Sörbom (eds) Structural equation models: Present and future, a festschrift in honor of Karl Jöreskog, Chicago, IL: Scientific Software International.

Broadberry, S. (2006) *Market Services and the Productivity Race, 1850-2000: British Performance in International Perspective* – Cambridge Studies in Economic History – Second Series (Cambridge: Cambridge University Press)

Distefano, C. (2002) 'The impact of categorization with confirmatory factor analysis' Structural Equation Model, 9 (3): 327-346.

Elms, D.K. and Low, P. (Eds.) (2013) *Global Value Chains in a Changing World* (WTO Publications, Geneva)

Fulcher, J. (2015) *Capitalism: A Very Short Introduction* (Oxford: Oxford University Press)

Gereffi G., Humphrey J. and Sturgeon T (2005) 'The governance of global value chains', Review of International Political Economy, 12 (1), pp.78-104.

Gibbon, P., J. Bair and S. Ponte (2008) Governing global value chains: an introduction. *Economy and Society* 37, 315-338.

Glyn, A. (2009) 'Functional Distribution and Inequality', in: Salverda and Smeeding, eds., *The Oxford Handbook of Economic Inequality* (OUP, Oxford) 104-5

Grossman, G.M. and Rossi-Hansberg, E. (2008) 'Trading Tasks: A Simple Theory of Offshoring', *The American Economic Review*, **98** (5), 1978-97, December.

Hall, P. A. and D. Soskice (2001), 'An Introduction to Varieties of Capitalism', in P. A. Hall and D. Soskice (Eds.), Varieties of Capitalism: The Institutional Foundations of Comparative Advantage (Oxford, OUP) pp. 1–68.

Herrenforf, B., Rogerson, R. and Valentinyi, A. (2014) 'Growth and Structural Transformation'. In Aghion, P. and Durlauf, S.N. (eds) *Handbook of Economic Growth*, Vol.2B, Elsevier, B.V., pp. 855-941.

Hodgson, G. M. (1994) Capital Theory in Hodgson, G. M., Samuels, W. J. & Tool, M. R. (Eds.) *The Elgar Companion to Institutional Economics.* Aldershot, Edward Elgar.

Hodgson, G. M. (1997) The Fate of the Cambridge Capital Controversy in Arestis, P., Palma, G. & Sawyer, M. (Eds.) *Capital Controversy, Post-Keynesian Economics and the History of Economics. Essays in honour of Geoff Harcourt.* London, Routledge.

ILO (2015) World Employment Outlook, available at http://www.ilo.org/legacy/english/weso/2015/WESO_jan2015.xlsx

Inklaar, R., M. P. Timmer and B. van Ark (2008) Market services productivity across Europe and the US. *Economic Policy* 23, 141-94.

Jorgenson, D.W. and Timmer, M.P. (2011) 'Structural Change in Advanced Nations: A New Set of Stylised Facts', *Scandinavian Journal of Economics*, **113** (1), 1-29.

Kaplinsky, R. (1998) 'Globalisation, Industrialisation and Sustainable Growth: The Pursuit of the nth Rent', Sussex: IDS - Institute of Development Studies Discussion Paper 365.

Kaplinsky, R., and Morris, M. (2001) *A Handbook for Value Chain Research*, Sussex: IDS - Institute of Development Studies

Lewis, P.C., Ryner, M. and Peng., F. (2017) Welfare Capitalism in Post-Industrial Times: Trilemma or Power Over Rents? *New Political Economy*, DOI: 10.1080/13563467.2017.1393405

Milberg, W.S., and Winkler, D. (2013) *Outsourcing economics: global value chains in capitalist development*, Cambridge and New York, Cambridge University Press.

Millberg, W.S. (2008) 'Shifting sources and uses of profits: sustaining US financialization with global value chains', *Economy and Society*, **37** (3), 420-51.

Mongiovi, G. (2002) Symposium on Piero Sraffa's Legacy in Economics. Classics and Moderns: Sraffa's Legacy in Economics. *Metroeconomica,* 53**,** 223-41.

Ngai, L. R. and Pissarides, C.A. (2007) 'Structural change in a multisector model of growth', *American Economic Review*, **97**, 429-443.

Nitzan, J. and Bichler, S. (2009) *Capital as power: a study of order and creorder*, London, Routledge.

OECD (2013) *Interconnected Economies: Benefiting from Global Value Chains*, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/9789264189560-en

O'Mahony, M. and Timmer, M.P. (2009) 'Output, Input and Productivity Measures at the Industry Level: the EU KLEMS Database', *Economic Journal,* **119** (538), 374-403.

Penrose, E.T. (1995) *The theory of the growth of the firm,* 3rd edn., Oxford, Oxford University Press.

Pierson, P. (2001) 'Post Industrial Pressures on the Mature Welfare States'. In Pierson, P. (ed) *The New Politics of the Welfare State,* Oxford, Oxford University Press, pp.80-104.

Porter, Michael E. (2004 [1980]) *Competitive strategy: techniques for analyzing industries and competitors*, New York/London, Free Press.

Rodrik, D. (2012) *The Globalization Paradox: Democracy and the Future of the World Economy* (W.W. Norton and Company, New York and London)

Ruggie, J.G. (1982) 'International Regimes,Transactions, and Change: Embedded Liberalism in the Postwar Economic Order', *International Organization* **36** (2): 379-415.

Salter, W. E. G. and W. B. Reddaway, 1960, *Productivity and Technical Change* (Cambridge University Press, Cambridge).

Triplett, J. E. and B. P. Bosworth (2004) *Productivity in the US Services Sector; New Sources of Economic Growth* (Brookings Institution, Washington DC).

Triplett, J. E. and B. P. Bosworth (2006) "Baumol's Disease" Has Been Cured: IT and Multifactor Productivity in US Services Industries, in: D. W. Jansen, ed., The New Economy And Beyond. Past, Present and Future (Edward Elgar, Cheltenham).

UN (2015) National Accounts Statistics: Main Aggregates and Detailed Tables 2014, available at http://unstats.un.org/unsd/nationalaccount/madt.asp

UNIDO (2016) INDSTAT2 database, available at https://stat.unido.org/

Uphadyaya (2013) Country grouping in UNIDO statistics, Development Policy, Statistics and Research Branch Working Paper 1/2013

Veblen, T. (1921) *The Engineers and the Price System* (pp. 169. B. W. Huebsch: New York).

Wernerfelt, B. (1984) 'A resource based view of the firm', *Strategic Management Journal,* **5**, 171-80.

Wolff, E. (1999) 'The productivity paradox: evidence from indirect indicators of service sector productivity growth', Canadian Journal of Economics, 32(2), 281-308.

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