Uneven growth in the extensive margin: a new explanation for the lag of agricultural economies*

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Abstract

Expanding the set of goods produced is typically a part of economic development. We document a new growth fact by showing that growth in the extensive margin is far from being balanced between sectors. Diversification in the agricultural sector is on average lower than in other activities. We introduce this fact into a simple model of trade to show the relevance of unbalanced diversification for regions that are specialized in the lagging sector. Diversity-loving consumers endogenously reduce the share of their expenditure devoted to the lagging sector. The region specialized in that sector receives a decreasing share of world income which results in diverging income and welfare trajectories with respect to the region producing in the dynamic sector. Appropriating a decreasing share of world value pushes downward the relative wage in this region and this lowers the price of its exports relative to that of its imports, resulting in terms of trade deteriorating. This result, separates our theoretical results from those obtained when divergence is the result of uneven productivity growth between sectors. We present empirical evidence for the main testable results of the model and, in particular, we find support for terms of trade adjustment enhancing, rather than softening divergence for agricultural countries. Our model is the first replicating these facts without the need of heterogeneous consumers or products, nor resorting to political or institutional explanations.

Keywords: diversification; agricultural economies; growth; welfare.
JEL Classification Numbers: F43, F62, O13, Q17.

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1 Introduction

The wealthiest economies in the world became rich by moving away from agricultural production (see for example Kuznets, 1971 or Maddison, 1980). A very important question in development economics is then, what is preventing agricultural regions from achieving the same welfare levels as those of industrialized regions? Is there something intrinsic to the agricultural sector pushing regions that remain specialized in it away from prosperity? Caselli (2005) points at sectoral differences in productivity as one of the most important reasons for income differences. Allowing for sector specific productivity growth rates yields country specific growth rates as long as some degree of specialization prevails. Still, uneven productivity growth does not automatically yield welfare divergence. Acemoglu and Ventura (2002) explain that economies for which output growth is above average tend to experience terms of trade deterioration. This terms-of-trade effect (TTE), is highlighted by the authors as a mechanism preventing divergence. While the TTE operates on average for a large sample of countries, at least to some degree, this paper shows that terms of trade movements may enhance rather than prevent income divergence for agricultural economies. Understanding the driving forces behind this pattern becomes crucial to properly explain development problems faced by economies in which comparative advantage lies largely on that sector, most notably in South America and Sub-Saharian Africa. These economies belong to different parts of the world income distribution: some are rich, others middle-income and many are poor. Our evidence shows that agricultural economies are significantly outgrown by other economies with otherwise similar characteristics, but nevertheless they experience terms of trade deterioration, further promoting their divergence. In the light of this evidence, it could be argued that there is something intrinsic to the agricultural sector, pushing terms of trade downward for economies specialized in it. In this paper, we argue that a lower diversification rate in the agricultural sector can help explain the reversed TTE we see in the data.

Economic development is characterized by productive capabilities being expanded in different dimensions. We focus in what is arguably the least explored of these dimensions, i.e. the expansion of the set of goods produced, which can be referred as the *extensive margin* of growth. Our contribution is twofold. First, we present evidence showing that growth in the extensive margin, is far from being balanced. In fact, diversification happens at a consistently lower rate in the agricultural sector. Second, we highlight the largely unexplored, but very intuitive role that uneven diversification can play to account for divergence enhanced by a reversed TTE. For this, we abstract from other sources of growth, i.e. productivity growth, quality improvements and structural change, allowing growth only in the extensive margin. We include our new empirical result into a simple model of expanding varieties and trade. Our model comprises two regions (N and S) and each is completely specialized in one of two industries (M and A respectively).[1] Within each industry, firms develop new products every period and we allow the rate of product creation to be sector-specific. In a first stage, we show that if consumers devote fixed shares of their expenditure to both goods (as is often assumed implicitly in similar models) the model is not able to reproduce welfare divergence between regions because, fixed expenditure shares between industries prevent any between-industry effect. As a result, diversification

[1]We can think of these regions as heavily specialized countries or alternatively as geographical regions spanning through national borders. If we follow the second approach, then we need to consider the outcomes at the country level as a weighted average of what happens between sectors, the weights being the importance of each sector in each country.

differences produce within-industry effects but have no impact on relative welfare between regions. However, when consumers are freed from fixed expenditure shares between industries, love for diversity may push them to devote a greater share of expenditure towards the industry in which diversification is larger (say M) in both regions, in detriment of A. In such a case, the total value of firms producing A decreases relative to those producing M, which drives income and welfare in N to dominate that in S. Under certain conditions, the wage divergence can be strong enough to make terms of trade movements work against S further enhancing the divergence process instead of softening it.

To the best of our knowledge, the fact that our model reproduces terms of trade deterioration for the lagging economy by using a strictly technological explanation, constitutes a novelty. Indeed, a version of the TTE is a usual result in models of uneven output growth. If consumers are set to devote a fixed fraction of their income to different goods, as is implicitly assumed when Cobb-Douglas preferences are imposed, uneven growth across sectors yields relative price changes that exactly offset productivity differences, resulting in a complete TTE as in Acemoglu and Ventura (2002). Even when consumers are allowed to shift expenditure shares across sectors following changes in relative prices, as when CES preferences between industries are set (see Feenstra, 1996 or Ngai and Pissarides, 2007), the strength of relative price adjustment in response to productivity growth differences, depends on the value of the parameter representing the elasticity of substitution across industries in consumers' utility function. When the parameter is above unity, these models reproduce a declining trend in the value sold by the lagging sector as the movement in relative prices less than compensate for changes in quantities. When the same parameter is below unity, uneven evolution of quantities is more than offset by relative price changes and the lagging economy increases its market share. In any case, prices always move to benefit the lagging economy, which contradicts the evidence for agricultural economies we present below.

Previous theoretical efforts providing potential explanations for a reversed TTE usually rely on preference-based arguments (see for example Matsuyama, 1992, Matsuyama, 2000, Foellmi and Zweimüller, 2008 or Boppart, 2014). In these models, heterogeneous goods or consumers are responsible for shifts in consuming patterns. As the world economy grows and consumers get richer, they shift expenditure away from basic needs and towards more sophisticated products. In this kind of settings the increasingly scarcer good can see its relative price fall if its demand has a low income elasticity. Although these contributions have enriched our understanding of consumers behaviour they have not provided a link between uneven growth and expenditure shifts between sectors, thus treating these two sources of divergence in income as independent forces. In contrast, the model proposed here is able to account for the declining relative expenditure on A, the fall in terms of trade of S and divergence of this economy with respect to N, without resorting to product-specific income elasticities or household-specific preferences. Our model suggests that technological differences and expenditure shifts between sectors may not be orthogonal to each other, proposing a very intuitive link between the two. This should not be interpreted as an argument against the existence of non-homothetic preferences, a feature for which plenty of evidence has been reported, or its macroeconomic consequences. Rather, our results suggest that the declining share of worldwide value being captured by the agricultural sector may not be solely driven by such preferences, but also by the fact that diversification in this sector is relatively less prolific. Our mechanism remains technologically driven in that it is only due to uneven development of products that consumers shift weights in their consumption across industries.

The current paper could also be considered as complement to Acemoglu and Ventura (2002). While that work highlights that terms of trade can operate as a force for diminishing returns at the country level, i.e. terms of trade deteriorate for countries growing the most, it leaves room for this effect to be offset by changes in technology and the demand for the goods that the country sells abroad. The mechanism put forward in the present paper provides justification for both differences in growth rates across countries and shifts in expenditure. Given that different sectors expand at uneven rates, it is expected that long-term growth rates differ between countries as long as some degree of specialization remains. Moreover, uneven diversification can account for expenditure changes as stressed in the simple model presented here.

By showing that growth in the extensive margin is uneven and highlighting its consequences for development, our paper provides a new argument to the literature pointing at specialization as a source of divergence. We underline potential development problems for regions that remain specialized in a lagging sector of the economy and in this respect our work is also related to the literature on structural change which highlights moving away from original specialization as a key feature of development.[2]

The importance of economic expansion in the extensive margin has been documented in many previous works. Connolly and Peretto (2003) shows that the number of firms in the US followed the impressive population growth of that economy over the XXth century. Broda and Weinstein (2010) show that 40 percent of household expenditure in the US is in new goods (i.e. products created in the last 4 years). The trade literature has also emphasized the positive connection between openness and growth in the extensive margin. Feenstra and Kee (2008) show that exporters to the US over the period 1980–2000 increased their exports in the extensive margin by 3.3%, a figure that matches their productivity growth over the period. Hummels and Klenow (2005) report that the extensive margin is responsible for 60% of the difference in exported value between countries of different sizes. Kehoe and Ruhl (2013) show that a 10% increase in trade between two partners during the period 1995-2005, is associated with a 36% increase in the extensive margin, and the importance of that margin is increasing with the duration of the period analysed.

One of the earliest contributions on the relationship between diversification and terms of trade can be found in Krugman (1989). That paper makes the point that, one of the reasons why fast growing economies do not face terms of trade deterioration is because they expand the set of goods they produce. At any point in time country X's exports face a downward demand curve, but since the country grows by expanding the set of products it supplies to the world, it can increase its supply without necessarily seen exports prices falling. More recently, Corsetti et al. (2013) present a model where product diversification can also offset terms of trade deterioration for a booming economy, but their model is set out to analyse what is known as the transfer problem, so focus is placed on effects through the capital account. Our model expands the framework in Krugman (1989) to a dynamic two-sector setting and focuses on between-industry differences given that our evidence highlights important differences across sectors.

Finally, our model is applied here to explain divergence of land abundant countries, since our empirical evidence supports diversification differences between the agricultural and the rest of good producing activities. Nevertheless, the mechanism stressed in the model is potentially valid in other contexts where diversification hap-

[2]A very long list in this literature would include Lewis (1954), Baumol (1967), Timmer (1988), Gollin et al. (2002) and Murata (2002) among many others.

pens at consistently different rates. Evaluating whether the mechanism plays a role in the relative success of economies that reallocate resources towards the service sector, could be a matter of future research.

The rest of the paper proceeds as follows. After a brief Section 2 introducing the data we use, Section 3 presents the main development facts that our paper aims at explaining, i.e. that agricultural economies are outgrown by others with otherwise similar characteristics and that terms of trade deteriorate for these economies. We review the existing literature and provide evidence specific to the group of countries that this paper targets when necessary. In Section 4 we present empirical evidence supporting the fact that constitutes the basis of the mechanism we put forward here and constitutes our main empirical contribution to the development literature: expansion in the extensive margin is lower in the agricultural sector than in the rest of good-producing activities. Section 5 fits the previous fact in a simple model of uneven diversification and trade that is able to explain facts in Section 3. A first part imposes Cobb-Douglas preferences between industries to show that a setting in which preferences are restricted too much is unable to yield welfare divergence between regions. A second part allows for endogenous expenditure shares between industries and replicates the main facts that emerge from the data. In Section 6, we present evidence for the main testable predictions of the model. Finally, section 7 concludes.

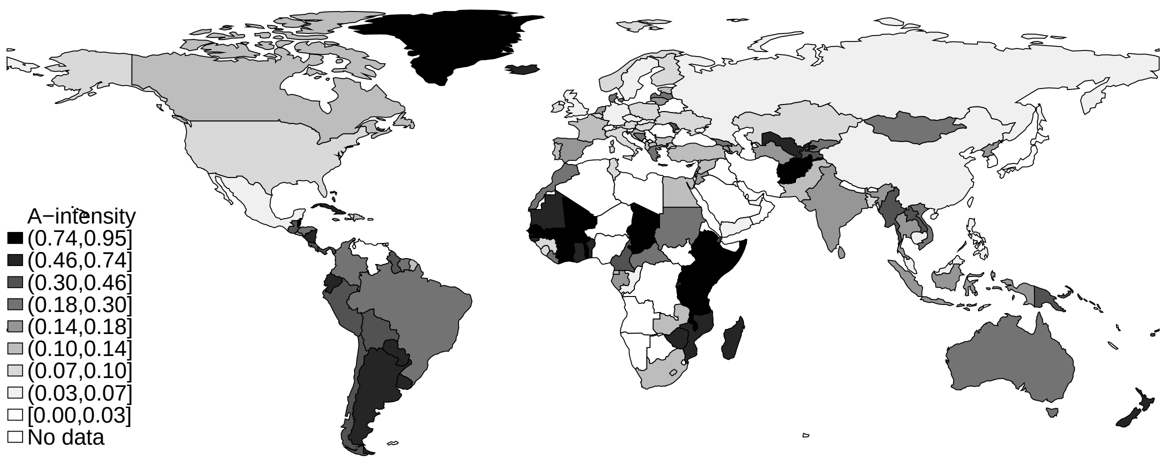
2 Data

Given that the aim of this paper is to consider how growth differences in the extensive margin may have an impact on terms of trade, it is natural to focus our attention not in production itself, but in the part of it that is traded beyond borders. We therefore consider international trade data as our main source of information. Our primary source is UNCOMTRADE which gathers trade flows at the five digit disaggregation level (SITC Rev1) since the year 1962, thus providing us with a sufficient time span to evaluate long-term trends. Data at this disaggregation level allows for a decent distinction of goods, for example, we can distinguish between good 02221 *Whole Milk and Cream* and good 02222 *Skimmed Milk*. More disaggregated data is available for shorter and more recent periods. We also consider data at six-digit disaggregation level since 1988 (HS0 classification). Such disaggregation level allows further detail, e.g. we can identify good 040221 *Milk and cream powder unsweetened* $<$ 1.5% *fat*. We use further datasets to show our results are robust the classification and the disaggregation level. On of these datasets is provided by Feenstra et al. (2005) which contains bilateral world trade flows at 4-digit disaggregation level (SITC Rev2) for the period 1962-2000. This dataset matches reports from exporters with those of importers, using UNCOMTRADE data, to establish consistent trade flows and is able to account for a larger country sample than that in the raw data. A similar procedure is followed in the construction of BACI92 which reports trade flows at 6-digit dissagregation level (HS0) for the period 1995-2007. Besides the difference in time span covered and disaggregation level, there is a relevant difference between data classified using the SITC and HS systems: while SITC is constructed according to goods' stage of production HS is based on the nature of the commodity. Our results prove robust to all these differences.

We focus on primary goods of the non-extractive type and refer to them as A-goods, while countries specialized in these products are referred to as A-countries. Unlike a large part of the literature on the resource curse, we explicitly exclude from our analysis goods based on natural resources of the extractive type (E-goods from now on). The reason for this exclusion lies within the main characteristics of E-goods: the fact that they are non-renewable and the possibility of depletion, links their prices to fundamentals that are different from those driving prices of A-goods. As will be evident in the next section, the mechanism formalized in our model does not consider these fundamentals.

To highlight the mechanism our model puts forward, we restrict our empirical results to the period 1962-2000. Indeed, the theoretical relevance of this work is to explore the conditions under which an economy can experience income divergence due to its specialization. We therefore need an environment that is sufficiently exempted from external shocks. In other words, our argument can only become evident in a world where some region specializes in A-goods, another specializes in M-goods and expenditure paths follow a natural trajectory driven by trade patterns between these two regions. As is well known, the years following China's trade liberalization program (after 2000), provided an important shock in the relative prices of primary to manufactured products which is certainly disruptive to the mechanism highlighted here.

Figure 1: Intensity of A-exports by country (2000)



Notes: The list of A1-goods was used for the construction of this figure (check Appendix). Data on exports from Feenstra et al. (2005).

The reader can find in the Appendix the list of products that are considered as A-products by this work. We focus on a restrictive list of products, A1, which includes only non-manufactured goods of the non-extractive type. We also provide results for two broader alternatives as robustness checks: A2, which also includes basic chemical compounds intensively using land, and A3, which further includes manufactured goods intensive in the use of that resource. Given the nature of our analysis it is important to state that none of our lists for agricultural products is a good proxy for homogeneous products. Rauch (1999) classifies goods in three categories according to how homogeneous they are in world markets: homogeneous products are sold in centralized markets, partially-homogeneous products are sold in decentralized markets but reference prices exist for them, and products for which none of the previous conditions apply can be considered non-homogeneous. That work presents two of such classifications, a 'conservative' list that aims at maximizing the last set and a 'liberal' one doing the opposite. Comparing our lists for agricultural products with all of Rauch lists we find that the strongest correlation is 0.3941 (corresponding to our A2 list and the liberal list including both types of homogeneous goods together), while smallest correlation is 0.1861 (between our list of A3 and Rauch's conservative list including only strictly homogeneous goods). Nevertheless, products classified here as agricultural are perceived by consumers as more substitutable than manufactured products. Using elasticity of substitution for 4-digit products presented by Broda and Weinstein (2006) we compare the mean and median elasticity of substitution for A and M-goods. Results are reported in Table 1 and show both statistics being higher for our lists of A-goods. Moreover, notice that as our list for agricultural products gets broader and more inclusive, the mean and median elasticity of substitution is reduced.

Table 1: Summary statistics for the elasticity of substitution within each list of goods

i	Ai				Mi			
	mean	median	sd	Obs.	mean	median	sd	Obs.
1	9.851	3.509	20.713	184	5.865	2.561	14.122	427
2	8.954	3.442	19.398	213	6.054	2.564	14.596	398
3	7.446	3.072	16.487	308	6.679	2.577	16.475	303

Notes: Elasticities of substitution are as reported by Broda and Weinstein (2006) for four-digit SITCR2 classification. List of products A_i, with $i = 1, 2, 3$, are as listed in the Appendix and list M_i corresponds to the complementing list after excluding extractive products.

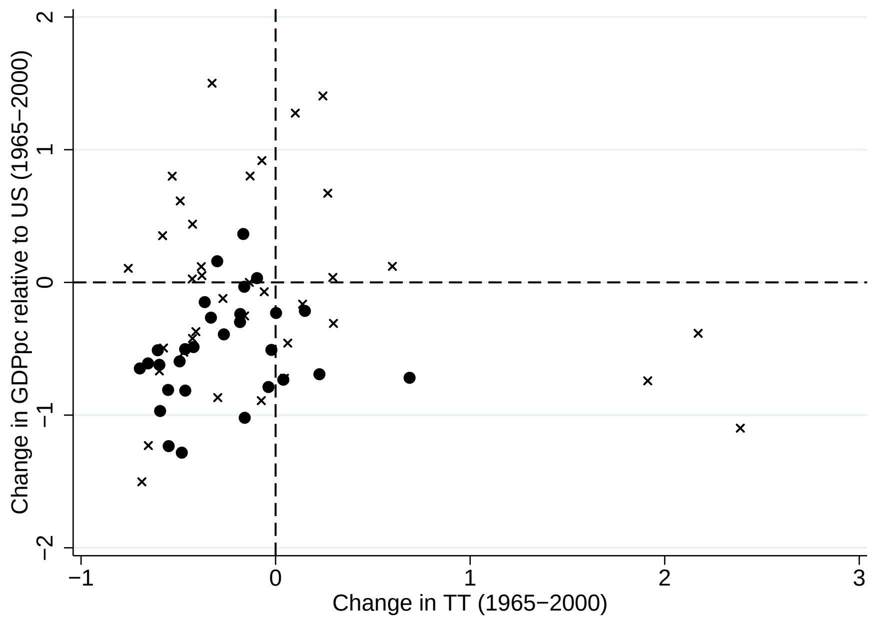
When looking at the share of A-goods in total exports, almost all countries show a decline over our period of analysis, a fact that is consistent with the structural change we have seen in the world economy during this period. Only 10 out of 165 countries show an increase in the importance of A1-goods in their exports during our period, the most salient cases being Venezuela and Bolivia for which the share of those goods at the beginning of the period was very low (below 12 and 5% respectively). A similar trend is present when considering A2 and A3 goods. Figure 1 shows intensity of exports in A1-goods for the year 2000 in a world map. As can be seen in this figure, the number of countries that remain largely specialized in A-goods by the end of the period is not very large and comprises regions with an important comparative advantage in the production of these goods, being rich in fertile land and not densely populated.

Our list for A-countries includes economies that have remained important exporters of A-products throughout the period considered here, since we want to provide a new explanation why agricultural economies have proven unable to converge to the wealthiest economies in the world in the absence of a structural change. We indicate A-countries by using two sets of dummy variables: variable Ai_j signals countries in which the share of Ai-goods exported is above j% for more than 30 years in our time span, while $Ai\_\jmath\_end$ equals one when the share of Ai-goods exported by an economy is above j% at the end of the period (with $i = 1, 2, 3$ and $j = 30, 40, 50$). The list of A-countries can vary greatly depending on the criteria used: the list can range from 54 countries when $A3_30 = 1$ to 15 when $A1_50end = 1$. Finally, to signal countries that were important exporters of agricultural products at the beginning of the period we compute $Ai\_j\_ini = 1$ when share of Ai-goods exported is above j% at each country's initial year in our sample. A list of such countries can rise up to 131 (when $A3dini30 = 1$).

3 Reversed terms of trade effect for agricultural economies

This section shows that agricultural economies experience on average a reversed TTE, i.e. they are outgrown and their terms of trade deteriorate during the same period, enhancing rather than offsetting, their income divergence.

Figure 2: Change in terms of trade and income relative to the US (1965-2000)



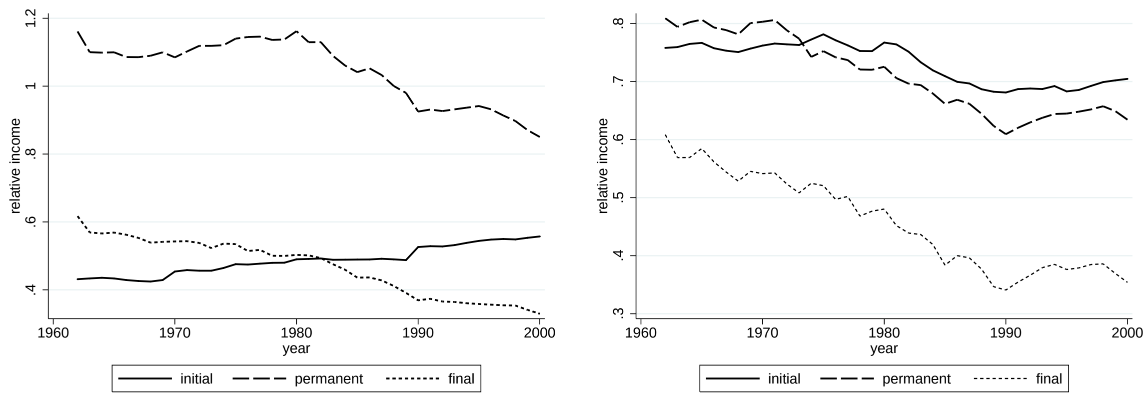
Notes: Change in terms of trade for the period 1965-1985 from Barro and Lee (1993) and for the remaining period from WDI. Data on real per capita GDP from PWT. Agricultural countries are signalled in full dots and defined as those for which exports of agricultural goods (A1 list in the Appendix) exceed 30% in 2000.

A simple way to summarize this fact is to plot the change in terms of trade against the change in income of each economy over a long period of time. Figure 2 does just that, taking the US economy as the reference for relative income. In this figure, we highlight with full dots the position of agricultural economies and we have included an horizontal and vertical line at value zero to separate the graph in four areas: those above the horizontal zero line have outgrown the US and those to the right of the vertical zero line have seen their terms of trade improving rather than falling over the period. A fully operational TTE would yield a negative relationship between these two variables. The correlation between both variables for the full set of observations is -0.01. Nevertheless, we can see that the group of agricultural economies contribute to a great extent against a stronger TTE for the full sample, since almost all of them are located in the bottom-left quadrant (the correlation for a sample ignoring A-countries is -0.15). In what follows we explore these patterns in greater detail.

3.1 Agricultural economies are outgrown by the rest

Although the idea that economies largely specialized in natural resources performed relatively worst than the rest has been around for some time, specially within policy circles, the empirical literature did not tackle this issue until the dawn of the twentieth century. In Sachs and Warner (1995, 2001) it is shown that countries with large endowments of natural resources had lower growth rates than the rest.

Figure 3: Evolution of per capita real income in A-countries relative the rest



Notes: Evolution of per capita GDP (constant prices) of A-countries (defined using A1 list, check Appendix) relative to sample average. The country sample is the entire world in the panel in the left. The panel of the right includes only countries belonging to the top 30% of the per capita GDP distribution. *initial* shows the evolution of relative per capita GDP of countries for which the proportion of A1-exports was above 30% at the initial year ($A1dini30 = 1$), *permanent* shows the same for countries for which exports in A1 where above the same threshold for 30 years or more in our sample ($A1d30 = 1$), and *final* exhibits the same for those for which the same threshold is surpassed at the end of the period ($A1d0030 = 1$).

In this paper we focus on a subset of those countries, i.e. those specialized in non-extractive primary products (A-countries). The graph in the left in Figure 3 shows the per capita income (in constant prices) of A-countries relative to world average. Real income of agricultural exporters is represented by the dotted and dashed lines, the former considering countries that were large exporters of agricultural products at the end of the period ($A1_30_end = 1$) and the latter including a sample of countries that exported agricultural products to a large extent for a long period of time ($A1_30 = 1$). The full line includes countries that were agricultural exporters only at the beginning of the period ($A1_30_ini = 1$). That panel clearly shows that exporting a large share of A-goods at some moment in time does not necessarily prevent future income convergence. Notice that the bold line depicting the relative income of countries with initial specialization in A-goods exhibits an upward trend consistent with a reduction in the income gap between this set of countries and world average. Nevertheless the figure also shows that remaining specialized in A-goods over the period is positively correlated with divergent growth: there is a clear divergent trend for the income per capita of exporters of A-goods in most years of the sample and also for those that finished the period being heavy exporters of those products. The panel in the right hand side shows a similar exercise including only countries that can be considered rich at the beginning of the period (their income per capita was among the top 30% in 1962) and a similar conclusion can be obtained. This result is robust to changing the variables used to define A-countries (similar pictures arise $\forall i = 1, 2, 3$ and $\forall j = 30, 40, 50$).

Table 2: Growth regressions

Dependant variable:	growth rate 1962-2000						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
east_asian	-61.979*						
	(34.091)						
enr6272	0.003	0.013*	0.009	0.007	0.014*	0.009	0.008
	(0.009)	(0.007)	(0.009)	(0.007)	(0.007)	(0.009)	(0.010)
pi	0.001	0.003	0.004	0.004	-0.000	0.001	0.001
	(0.003)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.004)
rgdpl	-0.000	-0.000	-0.000	-0.000	-0.000***	-0.000**	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
lnd100km	0.161	0.323	0.301	0.534			
	(0.287)	(0.349)	(0.381)	(0.321)			
dens65c	0.001	0.005	0.005	0.006	0.003	0.004	0.006
	(0.006)	(0.005)	(0.006)	(0.005)	(0.004)	(0.004)	(0.004)
Mal66a	0.219	0.403	0.448	0.209			
	(0.368)	(0.314)	(0.335)	(0.276)			
LIFEE060	0.031	0.021	0.029	-0.002	0.010	0.019	0.006
	(0.025)	(0.018)	(0.021)	(0.019)	(0.018)	(0.028)	(0.034)
CONFUC	146.405*	-0.328	-5.560	2.752			
	(75.718)	(7.441)	(8.932)	(5.859)			
safrica	-0.444						
	(0.669)						
laam	0.408						
	(0.494)						
Mining	-2.117	-2.897	-2.328	-2.303	-1.971	-0.804	-0.906
	(2.224)	(2.238)	(2.363)	(1.615)	(1.716)	(2.369)	(2.508)
SPAIN	-0.604***	-0.092	-0.289	-0.536**			
	(0.184)	(0.271)	(0.225)	(0.182)			
YrsOpen	0.442	0.416	0.410	0.421	0.592**	0.582*	0.517
	(0.366)	(0.331)	(0.347)	(0.249)	(0.278)	(0.322)	(0.453)
MUSLIM	0.547	0.448	0.469	0.159			
	(0.475)	(0.259)	(0.289)	(0.220)			
BUDDHA	71.816*	0.069	-0.037	0.022			
	(39.227)	(0.321)	(0.353)	(0.298)			
muller	0.758	0.556	0.350	-0.204	0.430	0.306	-0.132
	(0.432)	(0.317)	(0.386)	(0.370)	(0.319)	(0.335)	(0.389)
gov_C	0.038*	0.003	-0.015	-0.018	0.021	0.018	0.036
	(0.020)	(0.027)	(0.028)	(0.026)	(0.026)	(0.031)	(0.033)
pop_dens	-0.002	-0.005	-0.005	-0.006	-0.003	-0.004	-0.006
	(0.006)	(0.006)	(0.006)	(0.005)	(0.004)	(0.004)	(0.004)
RERD	0.002	0.001	0.001	-0.001	0.003	0.005	0.001
	(0.004)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.004)
A1_30_end		-0.456*			-0.715***		
		(0.227)			(0.177)		
A1_40_end			-0.318			-0.671***	
			(0.230)			(0.223)	
A1_50_end				-0.780***			-0.788***
				(0.156)			(0.192)
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	33	33	33	33	33	33	33
R^2	0.908	0.838	0.818	0.879	0.782	0.698	0.659

Notes: *, ** and ***, significant at a 10, 5 and 1% confidence level respectively. Robust standard errors in parenthesis. Controls are variables identified as robust growth regressors in Sala-i-Martin et al. (2004). See Appendix for definition of variables and data sources.

Table 3: Evaluating importance of A-countries dummy in growth regressions

Dependant variable:	growth rate 1962-2000										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
enr6272	0.013*	0.013*	0.012*	0.005							
	(0.085)	(0.075)	(0.071)	(0.539)							
pi	0.003	0.003	0.003	0.004	0.000*	0.000	0.000	0.000			
	(0.559)	(0.547)	(0.424)	(0.217)	(0.098)	(0.121)	(0.299)	(0.382)			
rgdpl	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	(0.350)	(0.302)	(0.299)	(0.158)	(0.120)	(0.105)	(0.005)	(0.004)	(0.004)	(0.002)	(0.001)
lnd100km	0.310	0.311	0.321	0.479*	0.064						
	(0.384)	(0.350)	(0.314)	(0.062)	(0.676)						
dens65c	0.005	0.005	0.005	0.007	0.004**	0.004**	0.003*	0.003**	0.003**	0.003*	0.003*
	(0.372)	(0.354)	(0.335)	(0.130)	(0.029)	(0.027)	(0.061)	(0.036)	(0.035)	(0.051)	(0.069)
Mal66a	0.403	0.403	0.462**	0.576***	0.139	0.139	0.234	0.201	0.203	0.201	
	(0.209)	(0.197)	(0.050)	(0.003)	(0.509)	(0.505)	(0.249)	(0.317)	(0.308)	(0.312)	
LIFEE060	0.021	0.021	0.022	0.035**	0.025**	0.027**	0.032***	0.030***	0.030***	0.031***	0.028***
	(0.250)	(0.230)	(0.168)	(0.031)	(0.016)	(0.011)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
CONFUC	-0.086										
	(0.991)										
Mining	-2.876	-2.878	-2.854	-1.733	-1.518	-1.449	-0.953	-1.001	-0.996		
	(0.216)	(0.189)	(0.188)	(0.434)	(0.208)	(0.240)	(0.357)	(0.319)	(0.317)		
YrsOpen	0.409	0.409	0.412	0.364	0.242	0.232	0.397**	0.402**	0.398**	0.426**	0.407**
	(0.217)	(0.199)	(0.190)	(0.163)	(0.296)	(0.295)	(0.024)	(0.027)	(0.028)	(0.013)	(0.024)
MUSLIM	0.464	0.464*	0.473*	0.356	0.158	0.143	0.133				
	(0.101)	(0.092)	(0.080)	(0.168)	(0.462)	(0.482)	(0.450)				
BUDDHA	0.112	0.114	0.143	0.243	0.703***	0.705***	0.720***	0.689**	0.690**	0.711**	0.735***
	(0.688)	(0.630)	(0.455)	(0.138)	(0.004)	(0.003)	(0.009)	(0.013)	(0.012)	(0.012)	(0.009)
muller	0.625*	0.625*	0.635**	0.643*	-0.109	-0.129					
	(0.069)	(0.051)	(0.041)	(0.054)	(0.669)	(0.595)					
gov_C	0.010	0.010	0.010								
	(0.690)	(0.678)	(0.643)								
pop_dens	-0.005	-0.005	-0.005	-0.007	-0.004**	-0.004**	-0.003*	-0.003**	-0.003**	-0.003*	-0.003*
	(0.373)	(0.358)	(0.339)	(0.131)	(0.033)	(0.032)	(0.070)	(0.042)	(0.041)	(0.059)	(0.079)
RERD	0.001	0.001									
	(0.697)	(0.680)									
A1_30_end	-0.507**	-0.508***	-0.489***	-0.512***	-0.246*	-0.252*	-0.272**	-0.293***	-0.290***	-0.264**	-0.246**
	(0.011)	(0.009)	(0.005)	(0.000)	(0.058)	(0.051)	(0.020)	(0.009)	(0.009)	(0.014)	(0.015)
_cons	-2.196**	-2.194**	-2.190***	-2.433***	-0.754	-0.778	-1.130**	-0.932**	-0.937**	-1.062**	-0.751**
	(0.015)	(0.013)	(0.009)	(0.002)	(0.261)	(0.244)	(0.044)	(0.046)	(0.043)	(0.017)	(0.014)
Obs	33	33	33	37	72	72	92	92	92	92	92
R^2	0.836	0.836	0.834	0.782	0.636	0.635	0.609	0.605	0.605	0.598	0.590

Notes: *, ** and ***, significant at a 10, 5 and 1% confidence level respectively. All estimations using heteroskedasticity-consistent standard errors. p-values in parenthesis. Controls are variables identified as robust growth regressors in Sala-i-Martin et al. (2004). See Appendix for definition of variables and data sources.

The same result obtains when controlling for other growth determinants. We perform growth regressions using the growth rate of the whole period as dependent variable and including as controls all variables identified in Sala-i Martin et al. (2004) as robust growth regressors. The controls selected in that work constitute a wide range of measures of basic growth fundamentals (initial wealth, investment costs, human capital, etc.), as well as indexes of institutional quality, regional, cultural and geographical characteristics. The reader can check in the Appendix the list of variables included, a precise definition of what they measure and the source were the information was extracted from. The first column in table 2 shows how the baseline regression looks like when all 20 controls are included. The rest of the table presents results for similar specifications but replacing geographical and regional dummies by a dummy signalling A-countries. For this task, we use variable $A1_j end$ which signals countries for which the share of A1-goods exported is above $j\%$ (with $j = 30, 40, 50$) at the end of the period (year 2000). In columns (2)-(4) variables excluded are those strictly geographical. For columns (4)-(7), I exclude even more controls related with geographical factors and therefore closely linked with the type of specialization of an economy. Results in Table 2 show that our variable indicating economies that remained specialized in A during the period 1962-2000 is highly significant and negative in most specifications. Similar results are obtained using alternative variables to signal A-countries. These results indicate that, even controlling for other robust growth determinants, having remained specialized in A-goods is negatively related to growth. A-countries tend to have lower growth rates over the period analysed here than countries with otherwise similar characteristics.

Table 3 presents an exercise to test how important our indicator of A-countries can be in growth regressions. The first column presents a regression with all 20 variables selected in Sala-i Martin et al. (2004), plus our main dummy variable $A1_3 0end$. In the following specifications (columns 2-13) I proceed to remove, one by one, the variable that turns out to be the least significant in the previous regression (largest p-value). I do not eliminate variables that are significant at a 10% confidence level so the exercise ends when all variables have reached that significance level. As can be seen, the variable signalling A-countries is never dropped out in this exercise and it remains within the group of significant regressors even when there is only five variables left. Moreover, our main variable is one of the few that presents significant coefficients in all specifications. Again, this result is robust to the use of alternative variables signalling A-countries. Table A.3 in the Appendix shows the result of a similar exercise using nominal income instead of real income since this approximates better the specification we have in the model. The same conclusion remains. Overall, our results indicate that there is robust evidence showing that countries that remained, to some extent, specialized in A-products during our sample period, experienced lower growth comparing with pairs with similar level of all other growth determinants.

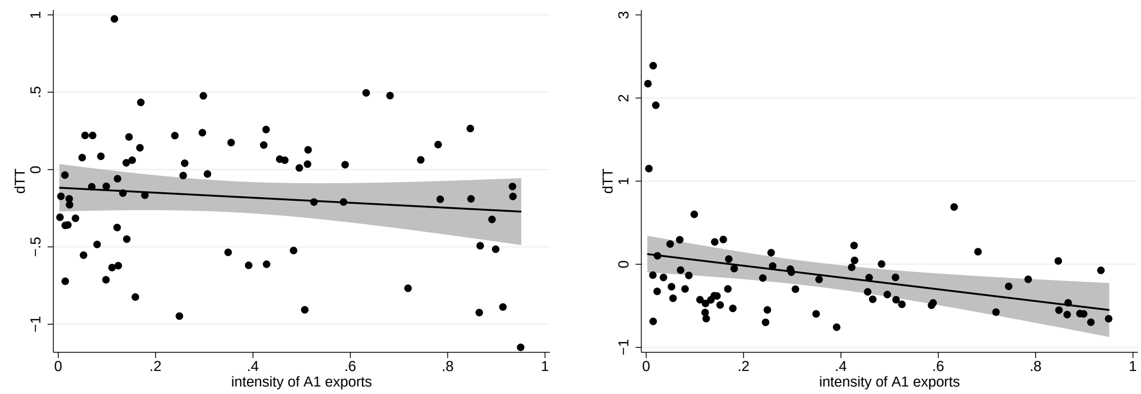
The evidence presented here is compatible with the well-known fact that economies that converge to the club of wealthiest countries in the world, do so by undergoing processes of structural change, i.e. reallocating resources from primary sectors towards more productive activities as they grow. The intuition that development is characterized by profound structural transformation has been around since (at least) Lewis (1954) or Baumol (1967). Nevertheless, remaining specialized in a given sector should not prevent income convergence if a perfect TTE was operational, i.e. if differences in quantity growth between sectors was perfectly compensated by relative price movements, as all countries should grow at the same rate. Even when the previous evidence is enough to discard a perfect TTE, it is not sufficient to refute the possibility of terms of trade improving, at least to some degree, for lagging economies.

3.2 Terms of trade fall for land-based economies

This section shows that lagging growth was not accompanied by improving terms of trade for agricultural economies. In fact, countries that specialize in the agricultural sector tend to see their terms of trade deteriorate and the fall seems to be stronger the larger the importance of that sector in the economy.

Concern regarding declining terms of trade for resource-intensive economies has been around policy circles for a long time. Since first stated several decades ago, the Prebisch-Singer hypothesis (see Prebisch, 1950 and Singer, 1950) was targeted by many empirical works. Most of these works focused on the evolution of the price of primary goods relative to manufactures (see for example Grilli and Yang, 1988, Ardeni and Wright, 1992, Cuddington, 1992, Harvey et al., 2010, Arezki et al., 2014 or Yamada and Yoon, 2014). Declining export prices of primary goods relative to manufactures only yield falling terms of trade for economies that are net exporters of the first group of goods and importers of the second. Moreover, this position needs to remain sufficiently constant over time for changes in trade composition not to offset price movements. As it turns out, many agricultural economies experienced important structural changes that affected the composition of their imports and exports over our period of analysis which is why some of the previously cited works are not conclusive regarding trends in terms of trade for all agricultural producers (Grilli and Yang, 1988 and Sarkar and Singer, 1991 explicitly make this point). A further condition is that relative productivity changes between sectors do not compensate for price losses something that also seems at odds with the evidence presented above.

Figure 4: Evolution of net barter terms of trade and intensity of A-exports



Notes: dTT is the change in the net barter terms of trade (as reported in the WDI) of each country and $A1$ is the share of $A1$-products over total exports of that country (check list of A1 products in the Appendix). The figure in the left presents results with data from the period 1985 and 2000 using net barter terms of trade reported in WDI. The figure in the right extends the period using data from Barro and Lee (1993) for years between 1965-1985. Export data is from Feenstra et al. (2005) in both cases. The grey area reports the 95% confidence interval of the fitted line (in black).

In this paper we focus directly on the evolution of terms of trade during our period of interest. We use two different data sources: for the period 1965-1985 Barro and Lee (1993) report 5-year changes in net barter terms of trade while for the period 1985-2000 we can use the index available in the World Development Indicators. In Figure 4 we plot the change in net barter terms of trade against the intensity of exports of A1-goods at the end of the period. The panel in the left considers total changes in the period 1965-2000 combining both available datasets. The panel in the right uses only the most recent data. According to both figures, it is not possible to state that terms of trade deteriorate for countries with a low share of A-exports. The fitted line shows a clear negative slope suggesting that larger shares of A-exports are correlated with a worst evolution of terms of trade. This negative correlation is significant at the 95% level when that share is relatively high (i.e. greater than 40% when considering the entire period and 25% when only the last 15 years are considered for A1 products). A very similar picture arises using our broader classifications for A-products: A2 and A3. Figure A.1 in the Appendix shows the relationship between the same two variables for a period covering also the first ten years of the new century. The change in terms of trade is still declining in the intensity of exports in that figure but we cannot reject the hypothesis that that change is negative even for largely agricultural economies. Comparison of that result and those in Figure 4 shows the aforementioned improvement in terms of trade for agricultural economies in the period 2000-2010, following China's entering world markets.

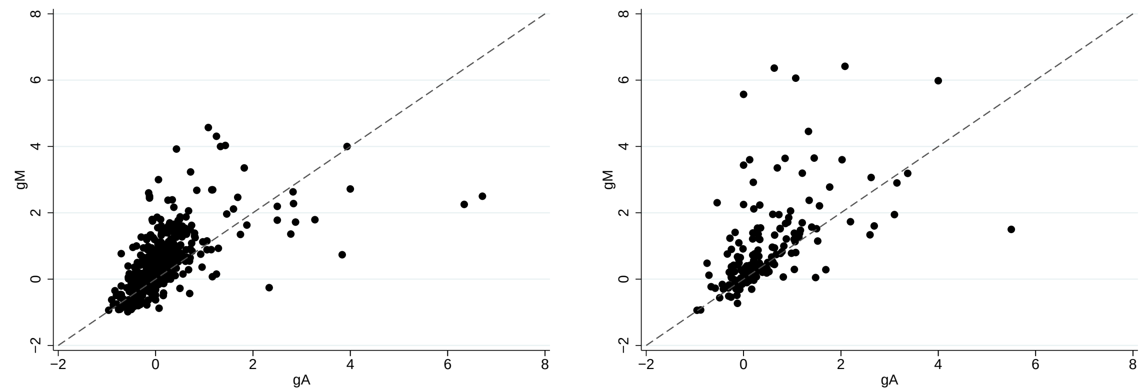
According to the evidence presented up to this point, land-based economies seem to experience a reversed terms of trade adjustment since a slower growth in their per capita income is not offset but rather enhanced by terms of trade movements. The puzzle of a reverted TTE for agricultural economies cannot be explained in a model of uneven quantity growth between sectors, but as will become evident in the next section, it can be replicated by a model in which consumers shift their expenditure away from primary products following their taste for diversity. The mechanism we put forward there relies then on one key assumption: diversification rates are different between sectors.

4 Uneven growth in the extensive margin

This section presents evidence showing that diversification is uneven between sectors. While previous works have highlighted that productivity growth can happen at differentiated rates between sectors (see for example Caselli, 2005, Vollrath, 2009), to the best of our knowledge, no previous work has shown uneven expansion in the extensive margin. Providing evidence in this direction constitutes the main empirical contribution of this paper. The rate at which countries are able to diversify their production of A-goods is significantly smaller than that of M-goods. To show this I compare diversification rates in both industries (g_A and g_M respectively) for each country. Each rate is computed as the percent change in the number of goods exported by a country in a given period.

In Figure 5, we plot the resulting rates along with a 45-degree line. For this figure, we consider A1-goods and define M1-goods as all those not classified as A1 or E products. The figure in the left plots diversification rates for 10-year periods starting in 1962, 1972, 1982 and 2000, using 4-digit exports from Feenstra et al. (2005). Inspection of that figure shows that while both rates are normally positive, the rate of diversification in manufactures tends to be larger than that in non-extractive primary goods for a given country-period. The figure in the right shows the same exercise, but using a different dataset with a larger level of disaggregation, although at the expense of a shorter time span due to data availability. We use 6-digit export data from BACI92 as reported by Gaulier and Zignago (2010) for the period 1995-2007 and construct three different lists of A-goods following a similar criteria as in Appendix A.1. The figure plots diversification rates for only one 13-year period starting in 1995. The reader can find in the Appendix similar figures using alternative classifications

Figure 5: Diversification rates in M and A goods for each country (g_{A1} and g_{M1})



Notes: Diversification rates g_{A1} and g_{M1} are computed as the percent change in the amount of different goods exported by a country in a certain period, using the list of A1 goods in the Appendix. Each dot represents a pair (g_{A1},g_{M1}) for one country in each sub-period. List of products A_i, with $i = 1, 2, 3$, are as listed in the Appendix and list M_i corresponds to the complementing list after excluding extractive products. The figure in the left plots diversification rates for 10-year periods starting in 1962, 1972, 1982 and 2000, using 4-digit exports from Feenstra et al. (2005). The figure in the right plots diversification rates for only one 13-year periods starting in 1995, using 6-digit exports from BACI92.

A2 and A3 for the construction of diversification rates (see Figure A.2), all throwing a similar pattern.

Table 4: Testing for differences in diversification rates

	4-digits			6-digits		
	$gM1 = gA1$	$gM2 = gA2$	$gM3 = gA3$	$gM1 = gA1$	$gM2 = gA2$	$gM3 = gA3$
mean(gM)	0.640	0.632	0.590	0.749	0.753	0.715
sd(gM)	4.595	4.474	3.168	1.257	1.275	1.155
mean(gA)	0.210	0.233	0.306	0.375	0.393	0.433
sd(gA)	1.668	1.725	2.333	0.806	0.759	0.819
Obs.	559	559	559	219	219	216
$Ha : gM < gA$	0.999	0.999	1.000	1.000	1.000	1.000
$Ha : gM \neq gA$	0.001	0.002	0.000	0.000	0.000	0.000
$Ha : gM > gA$	0.001	0.001	0.000	0.000	0.000	0.000

Notes: Each column presents the result of a mean-comparison t-test, where the null hypothesis is $g_{Mi} = g_{Ai}$ for $i = 1, 2, 3$. List of products A_i, with $i = 1, 2, 3$, are as listed in the Appendix and list M_i corresponds to the complementing list after excluding extractive products. The first three columns show the results for diversification rates computed for 10-year periods starting at 1962, 1972, 1982 and 2000 using 4-digit data from Feenstra et al. (2005). The last three columns uses 13-year diversification rates for a single year starting in 1995, using 6-digit data from BACI92. The first and third row give the mean of g_{Mi} and g_{Ai} respectively, while the second and fourth provide the respective standard deviation. The last three rows show the p-value of a t-test where the alternative hypothesis are $g_{Mi} < g_{Ai}$, $g_{Mi} \neq g_{Ai}$ and $g_{Mi} > g_{Ai}$ respectively.

We perform several mean tests, where the null hypothesis is that on average $g_A = g_M$, confirming that g_M is significantly different (larger) than g_A at a 1% confidence level. Table 4 shows the results of testing $g_{Mi} = g_{Ai}$ for $i = 1, 2, 3$, using alternative export data and filtering for a few outliers in the distribution of diversification rates. A similar table in the Appendix (Table A.4) shows results for all observations. Notice that, in all cases, we can reject the hypothesis of equality and inequality in favour of g_A with large confidence while the alternative hypothesis of $g_{Mi} > g_{Ai}$ cannot be rejected. We complement this evidence with a further test. Given that our diversification rates are computed by counting bins in product classification, they are sensible to how the classification is built. To reach results that are less dependent on classification we proceed to compute diversification rates in a given sector by calculating the average diversification in each of the 2-digit product lines that belong to that industry. Again we consider 10-year diversification rates starting at 1962, 1972, 1982 and 2000 using 4-digit data from Feenstra et al. (2005). Our results following this procedure are reported in Table 5, and the conclusions that we can extract from it further confirm our previous results. Overall our evidence provides strong support for the hypothesis that $g_A < g_M$.

Table 5: Testing for differences in diversification rates

		4-digits	
	$gM1 = gA1$	$gM2 = gA2$	$gM3 = gA3$
mean(gM)	0.454	0.453	0.464
sd(gM)	0.701	0.709	0.879
mean(gA)	0.250	0.268	0.305
sd(gA)	0.534	0.536	0.564
Obs.	417	417	415
$Ha : gM < gA$	1.000	1.000	1.000
$Ha : gM \neq gA$	0.000	0.000	0.000
$Ha : gM > gA$	0.000	0.000	0.000

Notes: Each column presents the result of a mean-comparison t-test, where the null hypothesis is $g_{Mi} = g_{Ai}$ for $i = 1, 2, 3$. List of products A_i, with $i = 1, 2, 3$, are as listed in the Appendix and list M_i corresponds to the complementing list after excluding extractive products. The reported diversification rate in each sector (A and M) is the simple average of diversification rates computed within every 2-digit line belonging to that sector. Every rate within a 2-digit line is computed for 10-year periods starting at 1962, 1972, 1982 and 2000 using 4-digit data from Feenstra et al. (2005). The first and third row give the mean of g_{Mi} and g_{Ai} respectively, while the second and fourth provide the respective standard deviation. The last three rows show the p-value of a t-test where the alternative hypothesis are $g_{Mi} < g_{Ai}$, $g_{Mi} \neq g_{Ai}$ and $g_{Mi} > g_{Ai}$ respectively.

Finally, we present evidence showing the same fact for varieties instead of products. The literature on trade with differentiated varieties often considers varieties as pairs of goods and country of origin. We compute the diversification rate of varieties within each broad industry (A and M) over time. This gives an idea on how have varieties in each industry evolve in the eyes of the global consumer. Comparing the resulting rates gives the same results as obtained before (see Table A.5), further confirming our result.

The result that $g_A < g_M$ is compatible with a growing literature arguing that technological linkages between production lines are not uniformly distributed. For example, Hidalgo et al. (2007) and Hausmann and Hidalgo (2011) construct a matrix of technological proximity between goods by computing, for each pair of goods, the minimum probability of both being exported by the same country. The resulting Product Space shows that technological proximity between industrial products is much greater than that between primary goods, suggesting that If this is true, then it easier for diversification to happen in the former rather than the latter.

5 The model

In this section we present a simple model in which product creation is the only source of growth. Such a model allows us to show that our empirical finding $g_A < g_M$ can play a key role in explaining income divergence enhanced by reversed TTE for agricultural economies.

In our model time is continuous and the world is composed of two regions (denoted $c = N, S$), one productive factor, i.e. labour (L), and two industries ($i = M, A$). The two regions are perfectly specialized in one industry: region N produces M-goods and region S produces A-goods.[3] Every firm in each industry undertakes two activities: they engage in R&D efforts to develop a new product and then they use that knowledge and labour to produce and sell their product. Their R&D efforts generate a private return but also spillovers to other firms within the industry.[4] Firms within a given sector are homogeneous. There is no population growth and labour cannot move between regions. Finally, there are no frictions to international trade.

5.1 Consumers

Consumers from country c face three choices at each moment t. First, they choose how much to consume and save, i.e. they decide their optimal expenditure level $E_c(t)$ for a given income. Then, they need to establish how much expenditure they devote to each industry, i.e. $E_{cM}(t)$ and $E_{cA}(t)$ with $E_c(t) = E_{cM}(t) + E_{cA}(t)$. In the third stage, consumers split their industry-specific expenditure among the different products of that industry available at each t.

Welfare in country c at t is defined as the present value of future consumption of the final good composite $Q_c(t)$, that is:

$$U_c(t) = \int_t^{\infty} e^{-\rho(s-t)} \ln [Q_c(s)] \, \mathrm{d}s \tag{1}$$

where $\rho > 0$ is the rate of pure time preference and is the same for individuals in both regions. At every moment in time t, consumers maximize (1) subject to the budget constraint $I_c(t) = E_c(t) + S_c(t)$ where $I_c(t)$ is current income, $S_c(t)$ are savings and $E_c(t) = Q_c(t)P_c(t)$ being $P_c(t)$ the price index of the composite. Each of the L_c consumers in country c is endowed with one unit of labour which is inelastically supplied in the labour market in return for a wage w_c. As a second source of income, consumers also receive the returns on their past savings at rate $r_c(t)$. The conditions for an optimal expenditure path arising from this dynamic problem are a transversality condition and the following Euler condition (EC)

$$\frac{\dot{E}_c(t)}{E_c(t)} = r_c(t) - \rho \tag{2}$$

[3]Although not necessary for our mechanism to hold, this assumption simplifies greatly the exposition. Specialization could be rooted in the relative endowments of other factors of production not included in our model (i.e. fertile land). By assuming specialization to be sustained over time we are explicitly ruling out the possibility that labour in the South becomes so cheap that they obtain comparative advantages in the M-sector. We want to abstract from this possibility given that the aim of the paper is to evaluate conditions under which countries that remain specialized in one sector may experience income divergence and reversed TTE.

[4]Departing from one sector models (as in Feenstra, 1996) provides our setting with a more natural context for the absence of spillovers between countries, which constitutes an important feature of uneven development models. Instead of assuming away international spillovers, in our model the absence of international spillovers is based on the difference in specialization between regions and industry specific spillovers.

Once consumers have established their optimal level of aggregate consumption they choose how much to spend in each industry $i = M, A$. We set a constant elasticity of substitution $\beta > 0$ between the composite of each industry:

$$Q_c(t) = \left[\omega_M Q_{cM}(t)^{\frac{\beta-1}{\beta}} + \omega_A Q_{cA}(t)^{\frac{\beta-1}{\beta}}\right]^{\frac{\beta}{\beta-1}} \tag{3}$$

with ω_i representing consumers' taste for composite of industry i and $\omega_M + \omega_A = 1$. The previous is a simple version of a heavily used specification for between-industry preferences. By using this function we show that, focusing on uneven product creation, our model is able to provide a technological explanation for the facts in Section 3, even within a framework that has been used extensively in the past. The mechanism proposed here dispenses the use of heterogeneous agents or goods still being able to account for terms of trade deterioration for the South, a result that, as we show, cannot be obtained in a similar model of output growth.

We denote $\alpha(t)$ the share of expenditure devoted to the A good, i.e.:

$$E_{cA}(t) = \alpha(t)E_c(t) \quad \text{and} \quad E_{cM}(t) = [1 - \alpha(t)]E_c(t) \tag{4}$$

At each t, consumers must decide how much of their expenditure in $i = M, A$, is spent in each product θ belonging to the set $\Theta_i(t)$ of available products in this economy. Free trade implies $\Theta_i(t)$ is the same in both regions $\forall i = M, A$. Consumer preferences over products within a given industry are CES, with $\sigma_i > 1 \forall i = M, A$ as the constant elasticity of substitution between any two products. This, together with Dixit-Stiglitz competition in the market of final goods (see Dixit and Stiglitz, 1977) yields:

$$\begin{aligned} Q_{ci}(t) &= \left[\int_{\theta\in\Theta_i(t)} q_{ci}(\theta,t)^{1-1/\sigma_i}\mathrm{d}\theta\right]^{1/(1-1/\sigma_i)} \\ P_{ci}(t) &= \left[\int_{\theta\in\Theta_i(t)} p_{ci}(\theta,t)^{1-\sigma_i}\mathrm{d}\theta\right]^{1/(1-\sigma_i)} \end{aligned} \tag{5}$$

where $q_{ci}(\theta, t)$ and $p_{ci}(\theta, t)$ represent quantities demanded and price paid in c for each product θ of industry i at time t. Without trade costs, the price charged for a certain product is the same in every market so $p_{ci}(\theta, t) = p_i(\theta, t)\ \forall \theta \in \Theta_i(t)$, which gives $P_{ci}(t) = P_i(t)$, $\forall i = M, A$ and $\forall t$. Consumers from different regions of the world have the same preferences, which is reflected here by the fact that ρ, $\alpha(t)$ and σ_i, are not country-specific. We then have $P_c(t) = P(t)\ \forall c = N, S$.

Expenditure in product θ of industry i at country c is defined as $e_{ci}(\theta, t) = q_{ci}(\theta, t)p_i(\theta, t)$, which by (5) gives

$$e_{ci}(\theta, t) = E_{ci}(t)\left[\frac{P_i(t)}{p_i(\theta, t)}\right]^{\sigma_i - 1} \tag{6}$$

Global expenditure is the sum of expenditure in each region of the world $E(t) = E_N(t) + E_S(t)$.

5.2 Producers

The modelling of producers resembles that in the model of endogenous growth with expanding product varieties and knowledge spillovers in Grossman and Helpman (1991, section 3.2). Potential entrants in industry i must develop a blueprint for producing good θ which implies incurring in a one-time sunk cost that is independent of future production. The fact that it is costless for producers to differentiate their production, together with all products entering the demand symmetrically, give firms no incentives to produce a good that is produced by a competitor, so firms and products are matched one to one. Once in business a firm continues to produce forever. Under this setting, after sinking the cost of developing a product, a firm can perfectly estimate their expected stream of income. Since only one sector operates in each country I can spare the use of a country sub-index in this section.

Technology in each industry i is represented by a linear cost function where labour is the sole input and there are no fixed costs. Dixit-Stiglitz competition in the final good sector implies that every firm in industry i sets the same price of

$$p_i(t) = \frac{\sigma_i w_i(t) z_i}{\sigma_i - 1} \tag{7}$$

In the previous expression, $z_i > 0$ is the marginal cost in terms of labour of final good production in sector i. Changes in parameter z_i reflect changes in efficiency in the production of final goods in that sector. Since in this paper we abstract from this source of growth we assume $z_i = 1 \forall i = M, A$ for simplicity.

Our assumption of homogeneous firms is sector i, together with expression (5) gives

$$Q_i(t) = n_i(t)^{\sigma_i/(\sigma_i-1)} q_i(t) \quad \text{and} \quad P_i(t) = n_i(t)^{1/(1-\sigma_i)} p_i(t) \tag{8}$$

where $n_i(t)$ is the number of existing products in industry i at time t.

Consumer's love for diversity and homogeneity of preferences across countries results in all firms of industry i being present and enjoying the same market share in both regions $1/n_i(t)$. The pricing rule in (7) implies that each firm has a mark-up over its sales of $1/\sigma_i$ so aggregate operating profits in sector i are $\Pi_i(t) = [E_{Ni}(t) + E_{Si}(t)]/\sigma_i$ and operating profits of any single firm within that sector are

$$\pi_i(t) = \frac{E_{Ni}(t) + E_{Si}(t)}{n_i(t)\sigma_i} \tag{9}$$

We can use the previous expression to write the present value at time t of a firm in sector i as

$$v_i(t) = \int_t^{\infty} e^{-[R_i(s) - R_i(t)]} \pi_i(s) \mathrm{d}s \tag{10}$$

where $R_i(t)$ is the cumulative discount factor for profits that firms in industry i consider at t. Equilibrium in the market of capital requires the returns from producing final goods to equal those of a risk-less loan. If, at t, an amount $v_i(t)$ is to be devoted to production in industry i for a period dt, then returns are given by $[\pi_i(t) + \dot{v}_i(t)]dt$. If the same amount is instead placed as a loan for the same period of time, the return equals $r_i(t)v_i(t)dt$. No arbitrage opportunities in the financial market imposes equality between the two options which yields the following No Arbitrage Condition (NAC):

$$\pi_i(t) + \dot{v}_i(t) = r_i(t) v_i(t) \tag{11}$$

New final products in industry i are developed following

$$\dot{n}_i(t) = \frac{L_{R,i}(t) K_i(t)}{a_i}$$

where $L_{R,i}(t)$ represents the amount of labour devoted to the creation of products and $K_i(t)$ is the level of knowledge in industry i. This stock of knowledge generates spillovers in the development of products and is specific to the industry. Given our assumption of regions fully specialized in different sectors, sector-specific spillovers implies no international spillovers. As explained in Grossman and Helpman (1991) knowledge spillovers are crucial for the model to reproduce sustained growth in equilibrium. We follow that work (and many others including Feenstra, 1996) in setting $K_{ci} = n_i$, that is, we set the stock of industry-specific knowledge to be equal to the amount of products existing in that industry, which is a simple way to introduce learning by doing at the industry level. Finally, $1/a_i$ represents the part of efficiency in R&D activities of industry i that is independent of spillovers. Then, defining the diversification rate in i as $g_i(t) = \dot{n}_i(t)/n_i(t)$, we reach

$$g_i(t) = \frac{L_{R,i}(t)}{a_i} \tag{12}$$

This expression allows for different causes for product growth to differ between industries. First, one industry can receive a larger resource input ($L_{R,i}$). Second, product creation may be easier in some industries than in others which would be reflected here by a smaller a_i.[5]

Finally, free-entry into production of final goods imposes the following Free-Entry Condition (FEC):

$$\frac{w_i(t)a_i}{n_i(t)} = v_i(t) \tag{13}$$

The left-hand side of this expression represents the cost of developing a new product in sector i, while the right-hand side constitutes the value of being able to sell that product in the final goods market.

5.3 Static equilibrium

From here on we define the growth rate of variable X as $g_X = \frac{\dot{X}}{X}$. At any moment in time t the static equilibrium of this model determines the vector (π_i, w_c, p_i, P_i, P, $L_{R,c}$, $L_{F,c}$, r_c, $g_{E,c}$, $g_{v,i}$, g_i) taking as given the vector (E_c, v_i, n_i). The variables in the second vector are given by history according to dynamic equations (2), (11) and (12) respectively. Optimal saving decisions determine the amount of resources that can be spent in t. Past investing decisions determine the evolution of firms' value. Finally, the path of optimal allocation of labour between activities in each region determines how many products are developed within each industry in each period and therefore how many products are available for consumption in both economies at t. How the value of α at t is determined depends on our assumptions regarding consumers preferences between industries. As detailed below, we consider two options for this: one where α is an exogenous parameter and another one where it is an endogenous variable of the model. In the latter case α is the result of the static equilibrium of the model so is fully know at t.

Taking as given the information of the second vector and knowing α, firms in industry i are able to know how many profits (π_i) they make (by 9), so they can take fully informed producing decisions. By (13), firms' optimal choices give wages (w_c). According to (7), a value of wages gives the price of each product p_i and they give price indexes P_i and P. Firms consider demand conditions for their production decisions so the market for each product clears. A given level of expenditure for consumers

[5] A very intuitive way to endogenize parameter a_i is to introduce firm heterogeneity in our model in the vein of Baldwin and Robert-Nicoud (2008) or Ourens (2016). In those works, efficiency in the development of new products depends on average efficiency in the production process in the industry.

automatically gives the level of consumption in each industry, by (4), and in each product by (6).

The labour market clearing conditions (LMC) impose that, at each country, the amount of the resource used in the development of products and in their production equals its fixed supply L_c. By (12) the amount of labour used in the development of products equals $L_{R,i} = g_i a_i$. For the production of the final good, each firm in industry i requires a quantity of labour of

$$L_{F,A} = \frac{\alpha E}{n_A p_A} \ , \ L_{F,M} = \frac{(1-\alpha)E}{n_M p_M} \tag{14}$$

so the total amount of labour used in industry i equals n_i times that amount, $\forall i = M, A$. This gives the following LMC

$$g_A a_A + \frac{\alpha E}{p_A} = L_S \ , \ g_M a_M + \frac{(1-\alpha)E}{p_M} = L_N \tag{15}$$

The above conditions give the allocation of resources to both final good production and R&D activities which, by (12), yields the growth rate of products in each industry. Merging (15) with the FEC in (13) and equations (7) and (9) we get:

$$g_i = \frac{L_i}{a_i} - (\sigma_i - 1)\frac{\pi_i}{v_i} \tag{16}$$

Trade balance requires exports of one region to match the exports of the other, i.e. $E_{S,M} = E_{N,A}$ which, by (4) yields the following Trade Balance Condition (TBC):

$$\frac{\alpha}{1-\alpha} = \frac{E_S}{E_N} \tag{17}$$

Using equations (7, 8, 9, 12, 13, 14, 15) plus an expression for P_{ci} determined by between-industry preferences and a value for α, we can solve for (π_i, w_c, p_i, P_i, P, $L_{R,c}$, $L_{F,c}$, g_i) at each t. A full solution for the model implies also finding the values for ($g_{E,c}$, $g_{v,i}$ and r_c) at t which give the values for the vector (E_c, v_i, n_i) in the future. From now on, we adopt aggregate expenditure in the North as our *numeraire* ($E_N = 1$). This immediately gives $g_{E,N} = 0$, $r_N = \rho$ (by 2) and $g_{v,M} = \rho - \pi_M / v_M$ (by 11) depicting the static equilibrium in N. Using EC and NAC for S, together with a dynamic version of the TBC we can fully characterize the solution in S.

As is well known, between-industry preferences as in (3) give an optimal consumption between industry composites ruled by the following condition:

$$\frac{\omega_A}{\omega_M}\left[\frac{Q_A}{Q_M}\right]^{-1/\beta} = \frac{P_A}{P_M} \tag{18}$$

were P_i is the price index of the composite produced by industry i.

This expression directly determines the existence of a TTE in models featuring output growth. Notice that if the production in one sector rises faster than in the other, its relative price must fall. Similarly, if technological progress is directed towards the reduction of costs reducing the relative price of a given sector, then relative quantities must adjust. The strength of the adjustment depends on the value of the elasticity of substitution between industries β. If $\beta = 1$ both composites are combined in a Cobb-Douglas function and the adjustment is one-to-one: the relative values produced and consumed of both industries remain constant configuring a perfect TTE as describes in

Acemoglu and Ventura (2002). In the case in which $\beta > 1$, the lagging sector benefits from some degree of TTE but this is not sufficient to fully compensate its technological lag so it loses world market share over time. Finally if $\beta < 1$, then the adjustment such that the lagging sector actually expands its traded value. As we see below, this is not necessarily the case when we focus on product creation as the growth mechanism.

Given our between-industry preferences in (3) we obtain the following expression for $\alpha(t)$:

$$\alpha(t) = \left[\left(\frac{\omega_M}{\omega_A} \right)^{\beta} \left(\frac{P_A}{P_M} \right)^{\beta - 1} + 1 \right]^{-1}$$

Merging the previous result with (8), we obtain:

$$\alpha(t) = \left[\left(\frac{\omega_M}{\omega_A} \right)^{\beta} \left(\frac{n_A(t)^{1/(1-\sigma_A)} p_A(t)}{n_M(t)^{1/(1-\sigma_M)} p_M(t)} \right)^{\beta - 1} + 1 \right]^{-1} \tag{19}$$

The static equilibrium in our model resembles that in Krugman (1989), the only difference being that our model allows for price differences between industries (we obtain Krugman's static equilibrium by imposing $w_S = w_N$ and $\sigma_A = \sigma_M$). At any t, the share of A-goods in the aggregate composite (α) is determined by the proportion of products of that industry in the total number of products (weighted by the elasticity of substitution within-industry σ_i) and relative prices. When goods from different industries are highly replaceable from one another, i.e. $\beta > 1$ a greater number of A-goods available or a lower price for any of the goods from that industry yields expenditure shift towards A-goods in detriment of the M-industry. On the other hand, when products of different industries are not so easy to substitute, i.e. $\beta < 1$, then the same conditions implies a reduction in the expenditure share devoted to A. The share of A-goods in world expenditure is time-variant since the number of products of each industry available to consumers at every t can change over time and so can relative prices, which follow wage movements. The only exception is when $\beta = 1$ in which case α is a parameter. Finally, notice that at every moment in time t, $\alpha(t)$ is known: since the number of varieties of both industries are given by history and wages (and therefore prices) are determined by the FEC, at each moment in time we know the value of $\alpha(t)$.

5.4 Dynamics of the model

A stable solution requires the following Stability Condition (SC) to hold (see the stability analysis of the model in the Appendix):

$$g_i = -g_{v,i} \tag{20}$$

This condition amounts to having a constant aggregate value of firms in a given industry. The FEC in (13) shows that the SC yields constant wages in both regions and by (7), this means constant prices of each product in both industries. Defining terms of trade for the South as p_A/p_M we see that terms of trade are constant even in a context of uneven product creation between industries. For a given level of global expenditure in both sectors and constant prices, greater product creation in one industry yields proportionally lower sales for each firm within that industry.

Merging (20) together with equations (11) and (16) we obtain:

$$g_i = \frac{L_i}{a_i \sigma_i} - \frac{\sigma_i - 1}{\sigma_i} \rho \tag{21}$$

According to 21 the diversification rate in both industries is constant and depends positively on the size of the producing economy (L_i). In other words, our model features a scale effect that is common in the literature. Diversification happens at a higher pace when product creation requires less units of labour (lower a_i), i.e. when efficiency in the $R\&D$ sector is larger. A smaller elasticity of substitution between varieties σ_i also contributes to larger sectoral diversification rate since it reduces firms' mark-up and therefore their expected stream of operating profits, ultimately reducing entry. Intuitively, firms face reduced incentives to develop new products in a given industry when consumers perceive goods in that industry to be highly replaceable by other goods within the same industry. For the model to reproduce positive growth we need to assume that the allocation of resources towards the development of new products is positive (i.e. $g_i > 0 \forall i = A, M$).

At equilibrium, a constant and positive flow of new products implies that their number evolves following:

$$n_i(t) = n_i(s)e^{(t-s)g_i} \tag{22}$$

The model yields uneven growth in the extensive margin if we allow larger diversification growth in one of the sectors. Without loss of generality we impose:

Assumption 1 *We assume the vector of parameters (a_c, L_c, σ_i, ρ) $\forall i = A, M$ and $c = S, N$ is such that $g_A < g_M$. This can be achieved by $a_A > a_M$, $\sigma_A > \sigma_M$, $L_A < L_M$ or a combination of some of these assumptions.*

While the assumption, i.e. $g_A < g_M$, is supported by the empirical evidence presented in Section 4, there is a diversity of conditions on the parameters of the model that can make the assumption hold. Notice we do not impose any particular condition since the results of the model do not require any more structure to replicate the facts we target here. Our empirical results in Table 1 suggest that the elasticity of substitution within each industry is much higher in the agricultural sector (the median σ_A is around 35% larger than the median σ_M), which partially explains the result $g_A < g_M$. Inspection of Figure 1 hints that population in agricultural economies is much lower than in the rest, which provides scale economies that also contribute to this outcome. Even considering the largest list of agricultural economies, the population advantage in non-agricultural economies is larger than 50% in the year 2000. Finally, while we do not have evidence regarding relative efficiency in product development between sectors, recent empirical evidence has shown that diversification is likely to be easier in labour and knowledge-intensive sectors where production processes may be more flexible to allow new developments. Hidalgo et al. (2007), suggest a measure of technological proximity between any two products based on the probability that both are exported by the same country. We use their proximity indicator to compute the average proximity that a good belonging to sector $i = A, M$ has with all other goods (see Table A.6). We find a lower average proximity for A suggesting that the average distance between a representative A-good and any other good in the product space is larger than that in M. According to this result diversification possibilities are more costly in the former than in the latter industry. In Table A.7 we show results for average proximity between a representative good in industry i and all other goods belonging to the same industry. The fact that the average proximity is also lower in A in this exercise suggests that within industry diversification is also more costly in the agricultural sector. A different stream of literature supporting the idea that product development is harder in A states that, firms from different sectors may face environments with varying degrees of stability. For example, Koren and Tenreyro (2007) shows that industry-specific volatility is a very important factor preventing development in poor countries. Overall, the evidence suggests that all of the conditions that contribute to $g_A < g_M$ may hold to some extent in reality.

5.4.1 Case with exogenous shares of expenditure between industries

While the mechanism put forward by our model is entirely technological, in this section we show that uneven diversification rates between industries cannot reproduce the facts in section 3 when too many restrictions are imposed in consumers' preferences. In particular, if we force consumers to devote an exogenous share of their expenditure to each industry ($\beta = 1$ so α is a parameter), terms of trade cannot deteriorate for the lagging economy. Under such restrictions preferences in (3) are reduced to a Cobb-Douglass specification. Exogenous shares of expenditure between industries is a common assumption in both trade and growth literature so it is useful to analyse the results of our model in this benchmark case. Moreover, this exercise puts forward interesting results regarding the mechanics of the model.

An exogenous α implies by definition

$$g_\alpha(t) = 0 \tag{23}$$

so equation (4) turns into:

$$E_A(t) = \alpha E(t) \quad \text{and} \quad E_M(t) = (1-\alpha)E(t)$$

Cobb-Douglas preferences between industries also gives:

$$P(t) = P_A(t)^\alpha P_M(t)^{1-\alpha} B \quad \text{where} \quad B = \alpha^{-\alpha}(1-\alpha)^{\alpha-1} \tag{24}$$

Under this setting, imposing $E_N = 1$ yields constant expenditure in both regions ($g_{E,S} = g_{E,N} = 0$), by (17). The EC (2) consumers follow in each region, determines that the returns from savings in both countries must equal the time preference parameter. By equality of preferences among consumers from both regions we can establish $r_S = r_N = r = \rho$.

Equation (21) determines a constant creation of new goods within each industry i. According to equation (9) profits for a given firm in sector i fall as the creation of new varieties reduces each firm's share of aggregate value ($g_{\pi i} = -g_i$). This is the competition effect within a given industry. Nevertheless aggregate profits in each sector ($\pi_i n_i$) are constant. This version of the model predicts then no income divergence since consumers' aggregate income is the sum of the mass of wages ($L_c w_c$) and aggregate firm's profits and both components remain unchanged over time.

Even with costs and mark-ups remaining unchanged, constant creation of new products in industry i implies, according to (8), that the price of the CES composite of that industry decreases at rate:

$$g_{Pi} = -\frac{g_i}{\sigma_i - 1}$$

By (24), this results in a falling aggregate price level consumers face.

The predictions of this version of the model regarding welfare outcomes are straightforward. At the equilibrium path, constant expenditure and falling price indexes yield growing real consumption in both regions. Since all consumers face the same prices across boarders, they enjoy the same reduction in the price index over time, so the evolution of consumers' purchasing power is the same in both regions. This means that, even though the level of welfare may differ between countries (due to different levels of constant expenditure), there is no welfare divergence at the equilibrium path. Intuitively, the fact that consumers devote fixed shares of their expenditure to the different industries means that greater product creation in one of them does not contribute to revenue differences between industries. Since wages are constant in both regions, a parallel path for firms' revenues between economies yields income and welfare growing at the same rate in both of them. Uneven diversification affects only the level of competition within-industry and therefore yields a larger reduction in sales for firms of the industry where creation is greater. In other words, the fact that S has specialized in an industry in which product expansion is less prolific, is innocuous in terms of its consumers' welfare since individuals in both regions spend constant shares of their income in both industries and this assigns constant shares of global value to each region. We can summarize these conclusions in the following result

Result 1 *With fixed expenditure shares to each industry, there is no income divergence. Product creation reduces prices consumers face and rises purchasing power in both regions at the same rate. Although welfare levels may differ across regions, there is no welfare divergence.*

It is important to notice at this point that, as highlighted in Acemoglu (2009, section 13.4), an equilibrium path with uninterrupted introduction of products yields growth in real income. Although our model does not feature improvements in the productive process of firms, the fact that consumers have love for diversity implies that an ever-expanding set of products increases consumer's utility over time. In this sense, the version of our model with exogenous expenditure shares between goods is able to reproduce increasing living conditions in both regions.[6]

However, our results in this section show that even imposing different expansion rates between regions, the model does not reproduce uneven development or welfare divergence. In other words, specializing in a relatively laggard industry is not a sufficient condition for income or welfare to follow a divergent path. The same outcome appears in models with different sources of real income growth, as long as exogenous shares of expenditure between industries are imposed. The compensating mechanism however does depend on the type of growth we consider. To show this notice that a constant α imposes a fixed expenditure ratio between sectors, so the relative value of production in each sector (i.e. $[Q_M P_M]/[Q_A P_A]$) must be constant too. In a model of uneven output growth, the ratio Q_M/Q_S changes over time accordingly, but constant expenditure devoted to each industry pushes relative prices to perfectly offset differences in quantities. If the technological gain is directed towards reducing costs then is relative prices that move accordingly and quantities compensate. In our model, equation (8) gives $(Q_M P_M)/(Q_A P_A) = (q_M p_M n_M)/(q_A p_A n_A)$. With constant relative wages, relative prices do not change over time. It is then clear that uneven product creation must be perfectly compensated by changes in the relative sales of the representative firm in each industry. We can therefore state the following result

Result 2 *With fixed expenditure shares to each industry, while welfare results resemble those that would obtain in a similar model of output growth, the adjustment mechanism is different. Uneven output growth would generate a perfectly compensating movement*

[6]A formal argument showing how product expansion in our setting implies growth, even in the absence of efficiency improvements in the production of final goods, is provided in Ethier (1982). Notice that the amount of resources used in the production of final goods in industry i is $q_i n_i(t)$. However, by (5), consumption of final goods is $Q_i = n_i(t)^{\sigma/(\sigma_i-1)} q_i$. This means that the ratio of consumed final goods to resources devoted to their production is $n_i(t)^{1/(\sigma_i-1)}$, which increases with the number of products in sector i.

in relative prices. In our model relative prices are constant and uneven diversification is perfectly offset by changes in relative quantities.

The previous result highlights that the type of growth considered by models affects their adjustment mechanisms. The implications of this conclusion to explain important development facts becomes evident in a context in which expenditure shares between sectors are endogenous.

5.4.2 Case with endogenous shares of expenditure between industries

Even though exogenous shares of expenditure between industries is a widely used simplifying assumption, it is against intuition and a large body of empirical evidence. Relaxing the assumption $\beta = 1$ imposed to consumer preferences between industries in the previous section, is a very easy way to endogenize expenditure shares and has been used extensively in the literature. In this section we show how this setting interacts with uneven product creation to reproduce the facts in Section 3.

A dynamic version of equation (19) gives:

$$g_\alpha(t) = [1 - \alpha(t)]H \left[\frac{g_A}{\sigma_A - 1} - \frac{g_M}{\sigma_M - 1} + g_{w,N}(t) - g_{w,A}(t) \right] \quad (25)$$

with $H = (\beta - 1)(\omega_M/\omega_A)^\beta$.This equation shows how expenditure in S is affected by the difference in product creation between sectors and the movement of relative prices, represented here by the change of relative wages. Given this expression it is easy to show that if industries were symmetric ($g_A = g_M$, i.e. Assumption 1 does not hold, $\sigma_A = \sigma_M$ and $p_A = p_M$) then $g_{E,S} = 0$. The solution in such a case would resemble that in the case with fixed α and no income nor welfare divergence would follow. However, under the current setting uneven diversification yields totally different results.

Understanding our expression for g_{ES} is crucial for our purposes because, given that the price index is identical for consumers in both countries, divergence in consumption between countries can only be driven by differences in expenditure. The interpretation of this equation is closely connected to that of (19). Notice that the sign of H is that of $\beta - 1$. From this expression it is clear that our model of product creation can replicate $g_{ES} < 0$ and $g_A < g_M$, as we see in the data, in a number of ways. One option is to have a sufficiently large technological lag in A that forces the term in brackets to be negative, combined with $\beta > 1$. A well known result that also appears in similar models with increasing output as the sole engine of growth, when the elasticity of substitution is above unity, the stagnant sector captures a decreasing share of world expenditure. In our model this translates to S facing decreasing expenditure possibilities.

A novelty in our model lays in the possibility of having $g_{ES} < 0$ even with $\beta < 1$. Remember that, in a model of output growth, the combination of $\beta < 1$ and uneven development yields expenditure shifts in favour of the lagging sector (as discussed when presenting equation 18), which would yield $g_{ES} > 0$ in our model. This is the result of consumers perceiving goods from the stagnant sector as hard to replace and showing a high willingness to pay for them. In such a case changes in relative prices more than compensate for differences in quantities. Our new result requires the term in brackets to be positive which is consistent with $g_A < g_M$ under one of two conditions: either because σ_A/σ_M is sufficiently small or because w_N/w_S grows at a sufficiently large rate. In the former case, even though product creation is smaller in A, consumer valuation of any new product A is very high (because substitutability within that industry is very low) so consumers' valuation of product development is larger in industry A even when actual diversification is smaller. In the latter case, a lag in product creation in sector A is accompanied by an increasing wage difference in favour of N, turning terms of trade against the southern economy. The conditions for this latter case to occur will become evident later in this section. Our results thus far can be summarized in the following result:

Result 3 *Our model with uneven product creation is able to replicate a decreasing real consumption path for the economy specialized in the lagging sector relative to the other, both if $\beta > 1$ and if $\beta < 1$. While the first possibility also exists in models of output growth, the second is specific to our model and arises if σ_A/σ_M is sufficiently small or p_M/p_A grows at a sufficiently large rate.*

As in the case with exogenous expenditure shares, setting $E_N = 1$ implies $g_{E,N} = 0$ and $r_N = \rho$. Again, we impose the SC in (20) both economies.[7] With our choice for the numeraire the northern economy plays the role of anchor in our model. The full solution for N is exactly the same as that in the previous section: diversification rate in M is constant and equals that in (21), firm profits and value are reduced by exactly that rate and wages and the return rate are constant.

Also like in the previous case, the diversification rate in S is a constant given by 12 but a time variant $\alpha(t)$ makes other endogenous variables in S change over time. In particular, we can obtain the time-varying rate at which expenditure in S evolves by merging the dynamic version of the TBC, with $E_N = 1$ we get:

$$g_{ES}(t) = g_\alpha(t)/[1 - \alpha(t)] \tag{26}$$

This equation shows in a very straightforward way that expenditure in S is directly linked to the share of consumption attracted by its firms in world markets. In the empirically relevant case in which that share is decreasing ($g_\alpha < 0$) then expenditure in S falls.

The rest of the solution in S is given by the EC and NAC for:

$$\begin{aligned} r_S(t) &= g_{ES}(t) + \rho && (27) \\ g_{vA}(t) &= r_S(t) - \frac{\pi_A}{v_A} && (28) \end{aligned}$$

At this point we can fully determine the path followed by the most relevant variables of this model. From here on we focus on the case in which $g_{ES} < 0$ and $g_A < g_M$ since this is the empirically relevant scenario. The fact that consumers in both regions shift their consumption shares in detriment of A ($g_\alpha < 0$) means that S earns a decreasing part of global expenditure so it has to reduce its consumption level relative to N. Provided our choice for the *numeraire*, this yields an ever decreasing path of expenditure for consumers in S, according to (17). This result constitutes the main difference between this version of the model and the one in the previous section. Since firms in S enjoy a decreasing market share in the world economy the returns they can give their owners (r_S) are also decreasing and are lower than the time-preference parameter (ρ) at every t according to (27). Notice that, since $r_N = \rho$, the previous result means that returns on savings in S are always lower than in N ($r_S(t) < r_N \forall t$). Intuitively, the fact that sector A is less able to diversify its production makes consumers shift their consumption away from the products of that sector. The

[7] We explore in the Appendix (section A.5) an alternative solution where the SC is not imposed in S. Most of our results still hold in this environment and in particular we shoe under which conditions the model replicates a reversed TTE.

South being specialized in the production of A-goods receives a smaller fraction of world income as a result. Given that expenditure is constant in the North, and since consumers from both regions face the same aggregate price index, the previous finding implies divergence in purchasing power between regions at a constant rate. We can therefore summarize our conclusions regarding the time path of relative consumption possibilities between regions as follows:

Result 4 *With endogenous expenditure shares to each good, uneven product creation generates shifts in demand shares in detriment of the industry that is able to diversify its production the least (A). Consumers in the region specialized in the relatively dynamic sector (N) obtain an increasing share of world income in detriment of the other region (S). Divergent paths in nominal expenditure translate into real consumption divergence between regions since all consumers face the same price index.*

Result 4 reviews our conclusions regarding the evolution of expenditure and real consumption of one country relative to the other. To reach conclusions regarding absolute trends of these aggregates we need to know the time path of the aggregate price index. Unlike the case with exogenous shares, when shares are endogenous, the evolution of the price index over time is not straightforward. To show this, notice that absent the restrictions imposed to (3) in the previous section, the price index for aggregate consumption is:

$$P(t) = \left[\omega_A \left(\frac{\alpha(t)}{P_A(t)}\right)^{(\beta-1)/\beta} + \omega_M \left(\frac{1-\alpha(t)}{P_M(t)}\right)^{(\beta-1)/\beta}\right]^{\beta/(1-\beta)}$$

and its dynamic version is given by:

$$g_P(t) = \frac{g_{PA}(t) + g_\alpha(t)\left(\frac{\omega_M}{\omega_A} - 1\right) + g_{PM}(t)\frac{1-\alpha(t)}{\alpha(t)}\frac{\omega_M}{\omega_A}}{1 + \frac{\omega_M}{\omega_A}\frac{1-\alpha(t)}{\alpha(t)}}$$

where a dynamic version of (8) gives

$$g_{Pi}(t) = g_{wi}(t) - \frac{g_i}{\sigma_i - 1}$$

The previous expressions show two reasons why the aggregate price level may not fall in the long run. The most obvious is that prices may not fall in the A-sector due to potentially rising wages in S. The second is that, even if the price of each industry composite decreases monotonically ($g_{P,i}(t) < 0$, $\forall i = M, A$ and $\forall t$), the aggregate price does not necessarily fall at every moment in time. In our case, if the price of the M-good maintains a positive difference with that of good A, an increase in the weight that the former has on the aggregate index P can make this index grow, even when its two main components (P_M and P_A) are decreasing.

A decreasing aggregate price level directly results in gains in purchasing power in the North as expenditure is constant in this region. Our model yields this result if

$$g_{PA}(t) + g_\alpha(t)\left(\frac{\omega_M}{\omega_A} - 1\right) + g_{PM}(t)\frac{1-\alpha(t)}{\alpha(t)}\frac{\omega_M}{\omega_A} < 0 \tag{29}$$

Whether this condition holds or not at some t depends on the speed and acceleration at which α is moving at that t.

A further condition is required for real consumption to increase in the South too. This happens when the fall in expenditure in this region is less strong than the fall in prices, which occurs if and only if:

$$g_\alpha(t) < [1 - \alpha(t)]g_P(t) \tag{30}$$

Conclusions regarding the evolution of real consumption in absolute terms, within each region, can be summarized as follows:

Result 5 *With endogenous expenditure shares to each good, the North experiences absolute gains in real consumption as long as condition (29) is met. If also condition (30) holds then the same is true for the South.*

To assess the evolution of income in both regions notice first that, while aggregate profits in N are still constant, this is no longer the case in S. Indeed, given our choice for the *numeraire*, the increasing market share that sector M experiences in world trade is exactly offset by the fall in global expenditure explained by decreasing expenditure in the South. In other words, $g_{\pi M} = -g_M$ still holds meaning that the aggregate mass of profits earned by M-firms is constant. On the contrary, in S we have:

$$g_{\pi A}(t) = -g_A + \frac{g_\alpha(t)}{1 - \alpha(t)} \tag{31}$$

Notice that the term in brackets is positive since both its components are. The fall in profits for any firm in S is now greater than what was found in the previous section. If α is a fixed parameter, the profits of any one firm fall in each sector due only to the reduction of each firm's share within that sector but aggregate profits in each sector are constant. An endogenous share to each industry creates a further loss for firms in S, given that the sector loses importance in the world market. This means that, unlike the model in the previous section and what happens in the current setting for N, aggregate profits in S fall over time (at rate $g_\alpha/[1 - \alpha(t)]$).

To establish the time-path of wages notice that using the FEC, (10) and (31) we obtain

$$g_{wS}(S) = \frac{g_\alpha(t)}{1 - \alpha(t)} \tag{32}$$

This expression shows that wages in S evolve in the same direction as the share of agricultural products in consumers expenditure. When that share is decreasing and the aggregate value of firms in S decreases then wages fall in the South. With aggregate profits falling in S, then decreasing wages imply falling income in that region. Notice that both variables are constant in N. The following result summarizes our findings regarding income divergence:

Result 6 *With endogenous expenditure shares, the model reproduces income divergence. While income is constant in N (i.e. it evolves following the time path of the numeraire which here is E_N), it decreases in S due to both falling aggregate firm profits and wages.*

Finally, we can show that our model reproduces terms of trade deterioration S. Notice that equation (7) establishes that the only determinant for changes in relative prices are changes in relative wages. Since wages are constant in N the price of products created there are also time invariant. The price of final production in S evolves following wages in that region and, according to our previous result, they fall when we have a shrinking α.

Result 7 *With endogenous expenditure shares to each good, terms of trade deteriorate for S when α falls.*

Notice that a situation of terms of trade falling in S is also one in which aggregate income in that region falls with respect to that in N. Such a situation constitutes what we call here a reversed TTE, i.e. terms of trade enhancing rather than offsetting income divergence. This result, which is supported by the evidence presented above for agricultural economies, is opposite to what can be obtained in models allowing for uneven output growth (for example Feenstra, 1996 or Ngai and Pissarides, 2007). In those models, relative prices always move in favour of the lagging sector configuring a positive TTE, and the magnitude of that effect determines whether the share of total expenditure that this sector is able to capture is increasing or decreasing.

In the Appendix we show that the last two results can be obtained if the South is allowed to follow an unstable path, under certain conditions (see section A.5). The reason why a model featuring uneven diversification rates is able to reproduce a reversed TTE for agricultural countries in a context of endogenous shares is similar to that already presented in the previous section to explain the adjustment mechanism of the model. In a model of uneven output growth, equation (18) implies adjustments in prices and quantities in relative sizes that are given by parameter β. But in a context of uneven product creation the same equation present a different adjustment mechanism. In fact, using equation (8), we can rewrite (18) as:

$$\frac{\omega_A}{\omega_M}\left[\frac{n_A(t)^{\frac{\sigma_A}{\sigma_A-1}}q_A(t)}{n_M(t)^{\frac{\sigma_M}{\sigma_M-1}}q_M(t)}\right]^{-1/\beta}=\frac{p_A(t)n_A(t)^{\frac{1}{1-\sigma_A}}}{p_M(t)n_M(t)^{\frac{1}{1-\sigma_M}}}$$

which can be rearranged to get:

$$\left[\frac{q_M(t)}{q_A(t)}\right]^{1/\beta}=\frac{\omega_M p_A(t)n_A(t)^{\frac{\sigma_A-\beta}{(\sigma_A-1)\beta}}}{\omega_A p_M(t)n_M(t)^{\frac{\sigma_M-\beta}{(\sigma_M-1)\beta}}} \tag{33}$$

The last expression shows that when diversification is included in the picture, terms of trade need not only compensate for changes in quantities produced of each product but also for uneven product creation. In our model, changes in relative prices follow changes in relative wages, as efficiency in the production of final goods remains unchanged. Relative wages are in turn determined by the aggregate value of firms in each sector (according to the FEC in 13) and ultimately by the TBC in (17). In cases were a decreasing share of expenditure being devoted to the A sector yields A-firms losing value relative to their pairs in M-sector, terms of trade deteriorate for the South. Differences in product creation between sectors are adjusted by changes in sales for individual firms so the equality in (33) holds.[8]

To recap, the version of the model that allows for endogenous shares is able to reproduce the facts that were presented in the previous sections and appear as important determinants in the development process of regions with comparative advantage in the production of primary products of the non-extractive type. Uneven product creation makes consumers shift their consumption in detriment of the lagging sector. This implies that the A-sector loses world market share and aggregate profits of firms

[8]Notice that, according to equation (33), independently of the growth mechanism chosen, a model could replicate terms of trade deterioration for the stagnant economy if consumer preferences towards sector composites change over time, i.e. the ratio ω_M/ω_A is endogenous. This preference-based approach is followed by works such as Matsuyama (1992), Matsuyama (2000), Foellmi and Zweimüller (2008) or Boppart (2014), among others.

in that sector decrease relative to the rest. Under certain conditions, wages in the South are decreasing too. Both components of income are constant in the North given our choice for the *numeraire*, so falling income in the South translates into income divergence between regions. Falling wages also yields terms of trade deterioration for the South. While terms of trade movements tend to offset divergence (TTE) in similar models of output growth, our model of product creation is able to account for a reversed TTE for agricultural economies which is supported by empirical evidence. Since all consumers face the same price index, income divergence translates into a divergent path in consuming possibilities.

6 Relevant testable predictions of the model

Our model with endogenous shares between industries is able to replicate divergence accompanied by a reversed TTE for economies specialized in agricultural production. This is consistent with the facts presented in Section 3. But this model gives other results plausible of being empirically tested. In particular, our model predicts that the share of A-goods declines in worldwide trade ($g_\alpha < 0$), since consumers in both regions of the world favour in their consumption the sector that is able to diversify its production the most in detriment of the agricultural sector. Also according to our model, the number of different A-products imported by each region grows less than that of other goods. In what follows we provide evidence supporting these results.

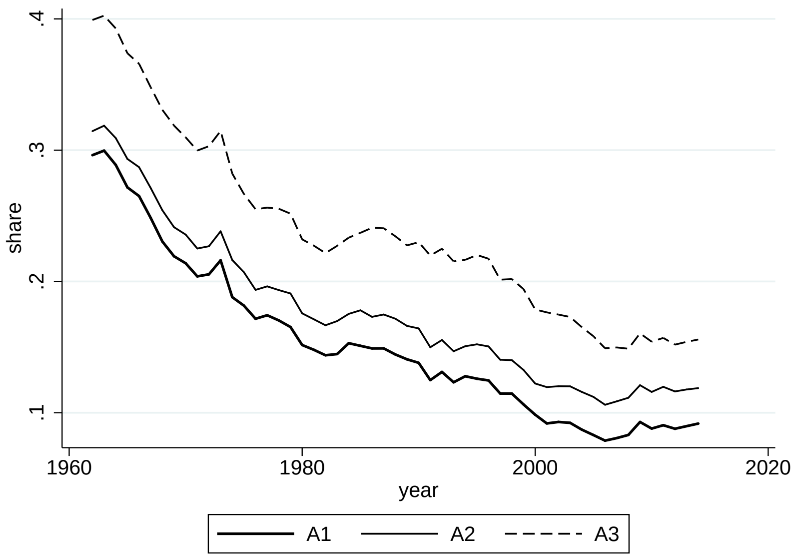
6.1 Declining share of A-products in international trade

As a part of the ongoing process of globalization, international trade has been on the rise. However, trends are differentiated between broad industries. In particular, the importance of land-intensive products in worldwide trade has been declining at least for the last fifty years. Figure 6 shows the share of A-goods in worldwide exports using all three groups of such goods defined in this work (A1, A2 and A3). The declining share is a consequence of trade in M-products growing more than the (also positive) growth in A and E goods (for which the share in trade shows no apparent trend).

Figure 7 shows a similar picture for imports of a sample of countries (including some of the most important economies in the world) reflecting how the same phenomenon can be found at the country level for economies with very different characteristics, i.e. large and small, rich and poor, industrialized and specialized in agricultural goods. Overall, it is hard to find cases where a clear negative trend does not shows up. A very notable case is that of China. As explained above, the rising importance of China in world trade after 2000 has increased the supply of manufactures in world markets while at the same time has dynamized the demand of primary products. What the above graph suggests is that, because even in a country like China the value of A-imports tends to fall, what has constituted good news for primary producers in the last decade and a half, could have been a level effect which might not continue in the future. In terms of Figure 6, the incursion of China in world markets may explain why the sharp negative trend in the share of A-goods in total trade saw a softening after 2000, but there is nothing preventing the previous trend to resume in the years to come.

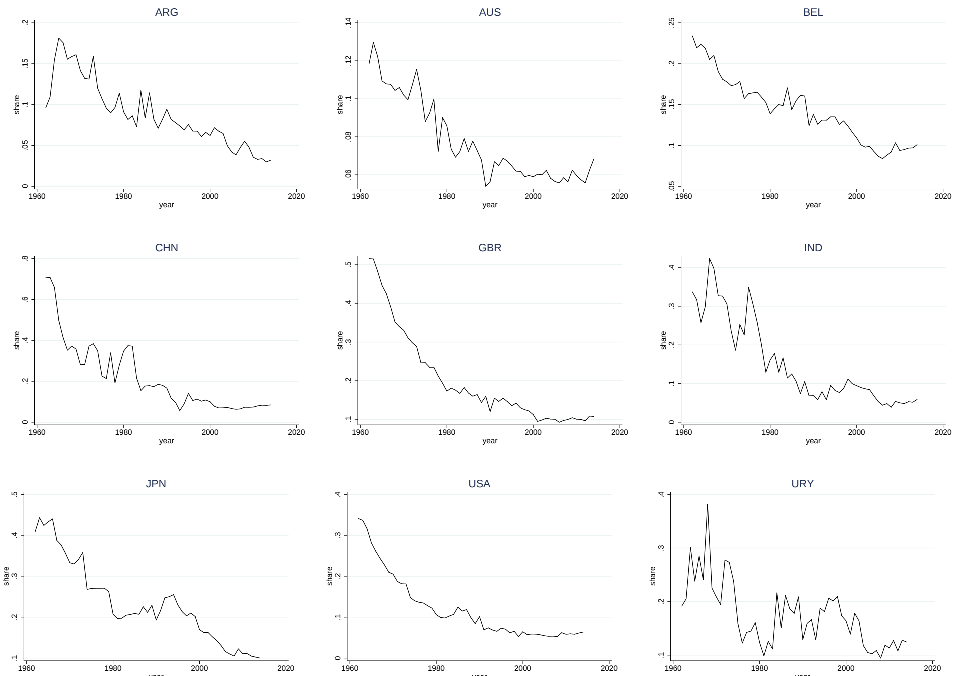
While the above trend could be partially driven by an increasing fragmentation of production of M-products, the data on exports of value added (available since 1992) shows that changes in the share value added represents in total exports in each sector

Figure 6: Share of A-goods in worldwide trade (1962-2015)



Notes: Share of world trade devoted to Ai-goods with $i = 1, 2, 3$. List of products A_i, with $i = 1, 2, 3$, are as listed in the Appendix. Computed using 4-digit data from Feenstra et al. (2005)

Figure 7: Share of A1-goods in imports for a sample of countries (1962-2015)



Notes: Share of imports devoted to $A1$-goods in Argentina, Australia, Belgium, China, Great Britain, India, Japan, United States of America and Uruguay respectively (check list of A1-goods in Appendix). Computed using 4-digit data from Feenstra et al. (2005)

are not large enough to revert the trends as shown above (see table 2 in Francois et al., 2015).

6.2 Unbalanced import diversification

Our simple model of uneven diversification has a clear prediction regarding import diversification patterns. Given that the main mechanism reproducing welfare divergence in our model is rooted in consumers finding an increasingly diversified supply of non-agricultural products, the model predicts that consumers in both economies purchase an increasing variety of products in general but a decreasing proportion of differentiated A-goods, regardless of absolute income paths in each region. When analysing the evolution of countries' import diversification we find that the time-trend is positive for the entire list of products, meaning that on average, countries tend to buy an increasing diversity of products from abroad. However, the proportion of differentiated A-goods imported reports a clear downward trend.

Table 6: Trends in import diversification

	(1) r1	(2) r2	(3) r3	(4) rE
year	-0.004***	-0.003***	-0.004***	-0.003***
	(0.000)	(0.000)	(0.000)	(0.000)
_cons	7.241***	6.958***	8.086***	5.755***
	(0.128)	(0.125)	(0.127)	(0.094)
Country-FE	Yes	Yes	Yes	Yes
Obs.	5712	5712	5712	5712
R^2	0.352	0.342	0.400	0.386

Notes: *, ** and ***, significant at a 10, 5 and 1% confidence level respectively. Standard errors in parenthesis. ri is the ratio defined as the number of different imports belonging to the Ai group to the total number of different products imported respectively (with $i = 1, 2, 3$). numE and rE are defined for extractive goods. Each ratio is computed using 4-digit data from Feenstra et al. (2005) for each year of the period 1962-2000.

Table 6 shows the results of panel regressions where a time-trend and country fixed-effects are the main regressors and the dependent variable is the ratio of the number of different A-goods imported to the total number of products imported. Results are presented for the baseline group of A-goods (A1) in column 1 and for the two alternative groups proposed here (A2 and A3) in columns 2 and 3. They show negative trends, significant at 1% confidence level for the ratio considering any selected group. We also find a negative trend for the ratio of imported E-goods to the total number of products imported (column 4) implying that a similar ratio of the remaining category, i.e. M-goods, is positive.

7 Conclusions

Explaining income differences across regions is one of the main tasks in economics. This work joins a large literature in pointing at specialization as a cause of welfare divergence. We restrict our attention upon the extensive margin of development, i.e. we focus on the role that uneven diversification between sectors, can play to account for key development facts left unexplained by previous literature, within a single framework. Our first contribution is to present evidence showing that the expansion in the extensive margin is far from being balanced between sectors: diversification happens at a lower rate in the agricultural sector than in the rest of good-producing activities. Our finding is in line with recent work showing that economic linkages are not uniformly distributed and in particular exhibits fewer links in primary activities.

Our second contribution is to show the relevance of our empirical finding in a simple model. Our model abstracts from all other sources of growth to focus on uneven diversification in a two country context with free trade and full specialization. When individuals value diversity in their consumption, a region specialized in an industry in which diversification is lower than in other activities, captures a decreasing fraction of global expenditure while devoting an increasing share of its domestic expenditure to imported products. This region experiences diverging income and welfare trajectories with respect to the region producing in the dynamic sector. Since domestic firms earn a decreasing share of world income, the wages they are able to pay to their workers also fall relative to those in the dynamic economy pushing down the price of exports relative to imports. The lagging economy experiences a deterioration in its terms of trade which further enhances its income and welfare divergence, a phenomenon referred here as reversed terms of trade effect. This result is supported by our empirical evidence, for the case of agricultural economies. Our model is, to the best of our knowledge, the first one to propose a purely technological explanation for this possibility.

We present empirical evidence supporting other interesting conclusions of the model. In particular, we show that the share of agricultural goods declines in worldwide trade in its entirety, and also in each region's imports considered individually. We also show that the number of different A-products imported by each region grows less than that of other goods.

The main conclusions of the present paper are in line with the literature on structural change, which argues that development is the result of reallocation of resources away from traditional activities. By showing that countries that remain specialized in the agricultural sector may experience welfare divergence our work highlights the benefits of between-industry resource reallocation as a path for development. Our story fits some well-known cases of divergence even within the developed world (Argentina, New Zealand, Uruguay, to name a few) without relying on institutional explanations or resorting to bad-policy arguments.

Finally, the mechanism proposed by our model is applied in this paper to explain divergence enhanced by terms of trade deterioration for agricultural producers. Our evidence showing that diversification in the agricultural sector is lower than in manufactures, provides sufficient support for it. This does not prevent our mechanism to be useful in other settings in which different set of products (or services) could exhibit unbalanced diversification. Future research in this matter should be welcomed.

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Appendix

A.1 List of A and E products

The following table lists the products considered in this work as A1, A2, A3 and E respectively. Every time we refer to M-goods, these are defined as the residual of the corresponding A category together with the E-set, i.e. the set of Mi comprises all products not included in Ai or E $\forall i = 1, 2, 3$. Our categorization is based in the SITCRev2 classification.

Table A.1: List of Ai and E-goods ($\forall i = 1, 2, 3$) as classified in SITCRev2 (4-digits)

SITCRev2 Code	**Description**	**A1**	**A2**	**A3**	**E**
0011-0XXX	Food and live animals chiefly for food	X	X	X	
1110-1XXX	Beverages and tobacco	X	X	X	
2111-2320	Hides, skins and furskins, raw; Oil-seeds and oleaginous fruit; Natural rubber Cork and wood; Pulp and waste paper; Textile fibres (other than wool tops and other combed wool) and their wastes (not manufactured into yarn or fabric)	X	X	X	
2331-23XX	Synthetic or reclaimed rubber, waste and scrap of unhardened rubber.				X
2440-271X	Cork and wood; Pulp and waste paper; Textile fibres (other than wool tops and other combed wool) and their wastes (not manufactured into yarn or fabric); Fertilizers, crude	X	X	X	
2731-28XX	Stone, sand and gravel; Sulphur and unroasted iron pyrites; Natural abrasives, N.E.S. (including industrial dymonds); Other crude minerals; Metalliferous ores and metal scrap				X
2911-29XX	Crude animal and vegetable materials, N.E.S.	X	X	X	
3221-3XXX	Mineral fuels, lubricants and related materials				X
4111-4XXX	Animal and vegetable oils, fats and waxes	X	X	X	
5111-51XX	Organic Chemicals		X	X	
5221-55XX	Inorganic chemicals; Dyeing, tanning and colouring materials; Medicinal and pharmaceutical products; Essential oils and perfume materials; Toilet, polishing and cleansing preparations				
5621-56XX	Fertilizers, manufactured		X	X	
5721-5XXX	Explosives and pyrotechnic products; Artificial resins and plastic materials, and cellulose esters and ethers; Chemical materials and products N.E.S.				
6112-65XX	Leather, leather manufactures, N.E.S., and dressed furskins; Rubber manufactures, N.E.S.; Cork and wood manufactures (excluding furniture); Paper, paperboard and articles of paper pulp, of paper or of paperboard; Textile yarn, fabrics, made-up articles, N.E.S. , and related products			X	
6611-6XXX	Non-metallic mineral manufactures, N.E.S.; Iron and steel; Non-ferrous metals; Manufactures of metals, N.E.S.				X
7111-7XXX	Machinery and transport equipment				
8121-8XXX	Miscellaneous manufactured articles				
9110-9XXX	Commodities and transactions not classified elsewhere in the SITC				

Using this classification, we end up with 184, 213, 308 and 628 different products in categories A1, A2, A3 and E, respectively out of a total of 1239 4-digit goods in SITCRev2.

A.2 Growth regressors

The following table lists the variables used in Section 3.1 as controls in growth regressions. These correspond to those identified in Sala-i Martin et al. (2004) as robust growth regressors. Along with the description for each variable, we provide the source were the data can be found.

Table A.2: Controls used in growth regressions

var name	Description	Data source
east_asian	Dummy for East-Asian countries.	Own construction following https://en.wikipedia.org/wiki/East_Asia
enr6272	Average enrollment rate in primary education (1962-1972).	Own construction using SE.PRM.TENR in WDI
pi	Average investment price level between 1960 and 1964 on purchasing power parity basis.	pi in PWT6.3 in Heston et al. (2011)
rgdpl	Logarithm of GDP per capita in 1960.	rgdpl PWT6.3 in Heston et al. (2011)
lnd100km	Proportion of country's land area within geographical tropics.	lnd100km in geodata.dta in Gallup et al. (2001)
dens65c	Coastal (within 100 km of coastline) population per coastal area in 1960's 1965.	dens65c in geodata.dta in Gallup et al. (2001)
Mal66a	Index of malaria prevalence in 1966.	Mal66a in malaria.dta in Gallup et al. (2001)
LIFEE060	Life expectancy in 1960.	X2 in Sala-i Martin (1997)
CONFUC	Fraction of population Confucian.	X53 in Sala-i Martin (1997)
safrica	Dummy for Sub-Saharan African countries.	X4 in Sala-i Martin (1997)
laam	Dummy for Latin American countries.	X5 in Sala-i Martin (1997)
Mining	Fraction of GDP in mining.	X59 in Sala-i Martin (1997)
SPAIN	Variable for former Spanish colonies.	X50 in Sala-i Martin (1997)
YrsOpen	Number of years economy has been open between 1950 and 1994.	X23 in Sala-i Martin (1997)
MUSLIM	Fraction of population Muslim in 1960.	X56 in Sala-i Martin (1997)
BUDDHA	Fraction of population Buddhist in 1960.	X51 in Sala-i Martin (1997)
muller	Average of five different indices of ethnolinguistic fractionalization which is the probability of two random people in a country not speaking the same language.	muller in othervar.dta in Easterly and Levine (1997)
gov_C	Share of expenditures on government consumption to GDP in 1960's 1961.	NE.CON.GOVT.ZS in WDI
pop_dens	Population per area in 1960.	EN.POP.DNST in WDI
RERD	Real exchange rate distortions.	X41 in Sala-i Martin (1997)

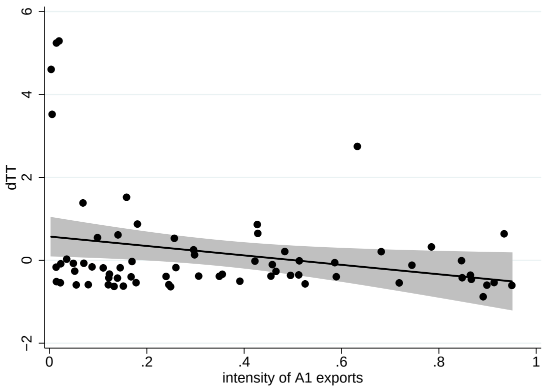
A.3 Testing for robustness of our results

Table A.3: Evaluating importance of A-countries dummy in growth regressions with nominal income

Dependant variable:	growth rate 1962-2000												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
enr6272	0.012	0.012	0.005	0.005									
	(0.300)	(0.279)	(0.544)	(0.526)									
pi	-0.003	-0.003	-0.007	-0.007*	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000**	-0.000**	-0.000**
	(0.454)	(0.397)	(0.142)	(0.057)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.010)	(0.012)	(0.011)	(0.010)
nominc	-0.000	-0.000	-0.000	-0.000	-0.000**	-0.000**	-0.000**	-0.000**	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	(0.157)	(0.112)	(0.403)	(0.457)	(0.021)	(0.020)	(0.012)	(0.011)	(0.009)	(0.001)	(0.000)	(0.000)	(0.000)
lnd100km	0.108												
	(0.621)												
dens65c	-0.008*	-0.008**	-0.005	-0.005	0.001	0.001	0.002	0.002	0.002	0.001	0.001	0.000	
	(0.090)	(0.045)	(0.209)	(0.201)	(0.234)	(0.236)	(0.205)	(0.168)	(0.148)	(0.440)	(0.548)	(0.642)	
Mal66a	0.522	0.515	0.453	0.430	0.373	0.385*	0.343*	0.327	0.333*	0.138			
	(0.143)	(0.129)	(0.155)	(0.158)	(0.112)	(0.086)	(0.098)	(0.105)	(0.093)	(0.482)			
LIFEE060	0.043*	0.044*	0.043**	0.043**	0.059***	0.060***	0.059***	0.057***	0.059***	0.062***	0.059***	0.059***	0.059***
	(0.095)	(0.076)	(0.040)	(0.032)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
CONFUC	10.376	9.291	6.099	6.303	-5.464*	-5.621*	1.808*	1.610*	1.823*	3.656***	3.753***	3.800***	3.945***
	(0.180)	(0.161)	(0.433)	(0.412)	(0.065)	(0.053)	(0.095)	(0.088)	(0.069)	(0.000)	(0.000)	(0.000)	(0.000)
Mining	-4.599**	-4.533**	-3.640**	-3.877**	-0.303								
	(0.019)	(0.019)	(0.046)	(0.016)	(0.801)								
YrsOpen	0.248	0.248	0.126										
	(0.293)	(0.270)	(0.617)										
MUSLIM	0.318	0.313	0.194	0.223	0.125	0.124	0.088						
	(0.241)	(0.234)	(0.455)	(0.412)	(0.533)	(0.529)	(0.637)						
BUDDHA	0.879**	0.882**	1.120***	1.144***	0.293	0.298	0.375	0.357					
	(0.035)	(0.027)	(0.000)	(0.000)	(0.550)	(0.542)	(0.448)	(0.460)					
muller	0.702**	0.685**	0.506	0.515	-0.234	-0.243	-0.224	-0.239	-0.234				
	(0.029)	(0.030)	(0.176)	(0.171)	(0.380)	(0.358)	(0.394)	(0.332)	(0.337)				
gov_C	-0.018	-0.018											
	(0.435)	(0.444)											
pop_dens	0.007	0.008*	0.005	0.005	-0.001	-0.001	-0.002	-0.002	-0.002	-0.001	-0.001		
	(0.139)	(0.067)	(0.211)	(0.202)	(0.540)	(0.566)	(0.227)	(0.193)	(0.175)	(0.468)	(0.580)		
RERD	0.003	0.004	0.002	0.002	0.001	0.001							
	(0.418)	(0.393)	(0.549)	(0.497)	(0.704)	(0.725)							
A1_30_00	-0.810***	-0.819***	-0.779***	-0.784***	-0.372***	-0.369***	-0.399***	-0.420***	-0.440***	-0.429***	-0.413***	-0.419***	-0.425***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.004)	(0.004)	(0.003)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.000)
_cons	-3.240***	-3.226***	-2.672***	-2.635***	-3.534***	-3.550***	-3.362***	-3.216***	-3.291***	-3.417***	-3.192***	-3.166***	-3.158***
	(0.002)	(0.001)	(0.008)	(0.007)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Obs	33	33	37	37	71	71	72	72	72	92	92	93	95
R^2	0.910	0.909	0.868	0.867	0.771	0.771	0.763	0.763	0.757	0.734	0.733	0.734	0.735

Notes: *, ** and ***, significant at a 10, 5 and 1% confidence level respectively. p-values in parenthesis. See Appendix for definition of variables and data sources. Nominal income is the product of real GDP at current prices and current prices as reported in PWT.

Figure A.1: Evolution of net barter terms of trade and intensity of A-exports for the period 1965-2010



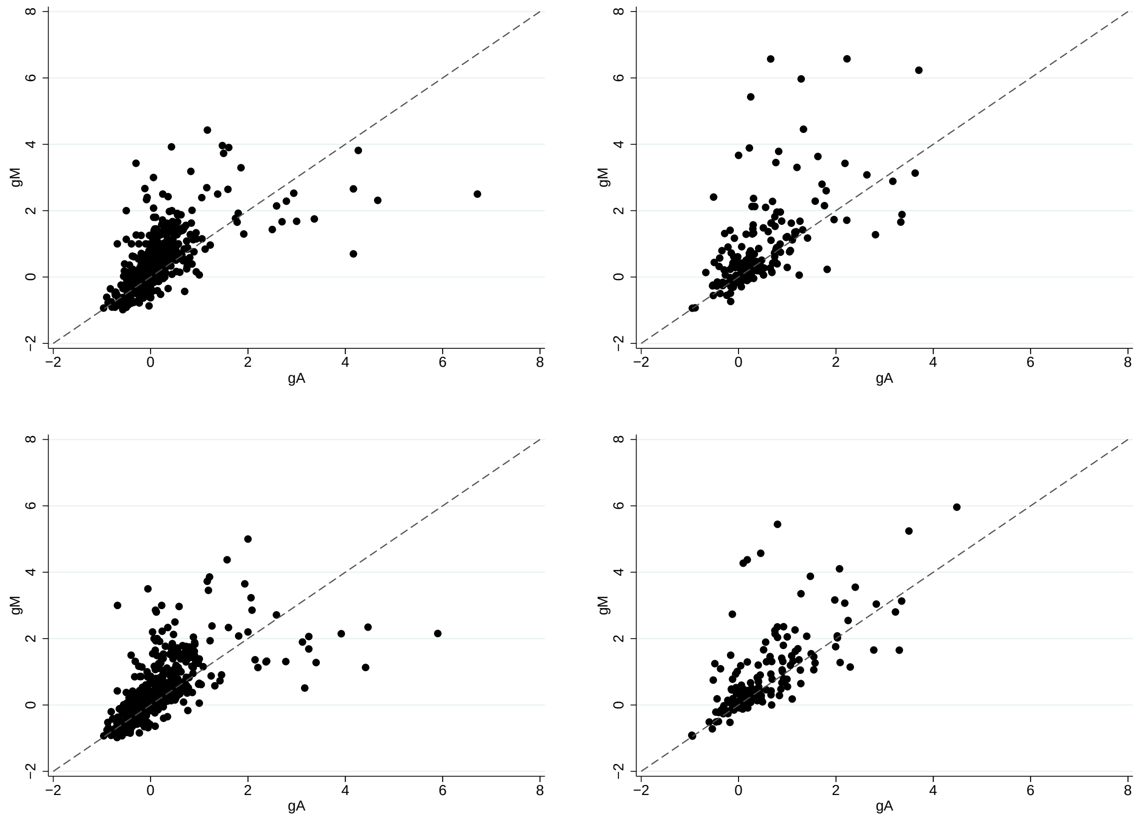
Notes: dTT is the change in the net barter terms of trade (as reported in the WDI) of each country and $A1$ is the share of $A1$-products over total exports of that country (check list of A1 products in the Appendix). Terms of trade from Barro and Lee (1993) for years between 1965-1985 and from WDI for the period 1985-2010. Export data is from Feenstra et al. (2005) in both cases. The grey area reports the 95% confidence interval of the fitted line (in black).

Table A.4: Testing for differences in diversification rates (all obs.)

	4-digits			6-digits		
	$gM1 = gA1$	$gM2 = gA2$	$gM3 = gA3$	$gM1 = gA1$	$gM2 = gA2$	$gM3 = gA3$
mean(gM)	0.798	0.863	0.810	0.792	0.794	0.863
sd(gM)	5.527	6.524	5.629	1.407	1.410	1.595
mean(gA)	0.269	0.274	0.366	0.463	0.474	0.510
sd(gA)	2.171	1.977	2.708	1.542	1.411	1.239
Obs.	561	561	561	220	220	220
$Ha : gM < gA$	1.000	0.998	0.999	1.000	1.000	1.000
$Ha : gM \neq gA$	0.001	0.004	0.003	0.000	0.000	0.000
$Ha : gM > gA$	0.000	0.002	0.001	0.000	0.000	0.000

Notes: Each column presents the result of a mean-comparison t-test, where the null hypothesis is $g_{Mi} = g_{Ai}$ for $i = 1, 2, 3$. The first three columns show the results for diversification rates computed for 10-year periods starting at 1962, 1972, 1982 and 2000 using 4-digit data from Feenstra et al. (2005). The last three columns uses 13-year diversification rates for a single year starting in 1995, using 6-digit data from BACI92. The first and third row give the mean of g_{Mi} and g_{Ai} respectively, while the second and fourth provide the respective standard deviation. The last three rows show the p-value of a t-test where the alternative hypothesis are $g_{Mi} < g_{Ai}$, $g_{Mi} \neq g_{Ai}$ and $g_{Mi} > g_{Ai}$ respectively.

Figure A.2: Diversification rates in M and A goods for each country (g_{Ai} and g_{Mi} with $i = 2, 3$)



Notes: Diversification rates g_{Ai} and g_{Mi} are computed as the percent change in the amount of different goods exported by a country in a certain period, using the list of Ai goods in the Appendix, for $i = 2, 3$. Each dot represents a pair (g_{Ai},g_{Mi}) for one country in each sub-period. Figures on the left plot diversification rates for 10-year periods starting in 1962, 1972, 1982 and 2000, using 4-digit exports from Feenstra et al. (2005), while figures on the right plot diversification rates for only one 13-year periods starting in 1995, using 6-digit exports from BACI92.

A.4 Stability in the model with exogenous expenditure shares

Setting expenditure in N as our *numeraire* ($E_N = 1$) yields, by (17), constant expenditure in both regions ($g_{E,S} = g_{E,N} = 0$). The Euler equation consumers follow in each region (2), determines that the returns from savings in both countries must equal the time preference parameter. By equality of preferences among consumers from both regions we can establish $r_S = r_N = r = \rho$.

With values of E_c, v_i and n_i given by history ($\forall c = N, S$ and $i = A, M$) and α being a parameter of the model, firms are able to compute their profits which amount to $\pi_M(t) = \frac{(1-\alpha)(E_S+1)}{\sigma n_M(t)}$ and $\pi_A(t) = \frac{\alpha(E_S+1)}{\sigma n_A(t)}$. Then we can express the full solution of the model in terms of known variables π_i and v_i. We can re-write the NAC in (11) as:

$$g_{v,i} = \rho - \frac{\pi_i}{v_i} \tag{A.1}$$

Using (13) and (15) we get an expression for the diversification rate in each sector:

$$g_i = \frac{L_c}{a_i} - (\sigma - 1)\frac{\pi_i}{v_i} \tag{A.2}$$

where $c = S$ if $i = A$ and $c = N$ if $i = M$.

Table A.5: Testing for differences in diversification rates (varieties)

	4-digits		
	$gM1 = gA1$	$gM2 = gA2$	$gM3 = gA3$
mean(gM)	0.073	0.070	0.093
sd(gM)	0.541	0.539	0.554
mean(gA)	-0.116	-0.099	-0.071
sd(gA)	0.366	0.378	0.417
Obs.	44	44	44
$Ha : gM < gA$	1.000	1.000	1.000
$Ha : gM \neq gA$	0.000	0.000	0.000
$Ha : gM > gA$	0.000	0.000	0.000

Notes: Each column presents the result of a mean-comparison t-test, where the null hypothesis is $g_{Mi} = g_{Ai}$ for $i = 1, 2, 3$. Diversification rates measure the percentage change in the quantity of pairs (country of origin-product) at the beginning and end of 10-year intervals starting at each year of the period 1962-1992. We use 4-digit data from Feenstra et al. (2005). The first and third row give the mean of g_{Mi} and g_{Ai} respectively, while the second and fourth provide the respective standard deviation. The last three rows show the p-value of a t-test where the alternative hypothesis are $g_{Mi} < g_{Ai}$, $g_{Mi} \neq g_{Ai}$ and $g_{Mi} > g_{Ai}$ respectively.

Table A.6: Summary statistics by sector: proximity of goods

i		Ai			Mi	
	mean	sd	Obs.	mean	sd	Obs.
1	0.143	0.047	195	0.179	0.044	423
2	0.147	0.048	222	0.179	0.044	396
3	0.158	0.051	312	0.177	0.043	306

Notes: Proximity as as reported by Hidalgo et al. (2007). We compute the average proximity of each product with all other products and then report the average of that by sector. List of products A_i, with $i = 1, 2, 3$, are as listed in the Appendix and list M_i corresponds to the complementing list after excluding extractive products.

Table A.7: Summary statistics by sector: proximity of goods within a sector

i		Ai			Mi	
	mean	sd	Obs.	mean	sd	Obs.
1	0.159	0.045	195	0.201	0.051	423
2	0.156	0.044	222	0.203	0.051	396
3	0.163	0.046	312	0.208	0.052	306

Notes: Proximity as as reported by Hidalgo et al. (2007). We compute the average proximity of each product with all other products belonging to the same sector and then report the average of that by sector. List of products A_i, with $i = 1, 2, 3$, are as listed in the Appendix and list M_i corresponds to the complementing list after excluding extractive products.

The above solution allows the ratio $\frac{\pi_i}{v_i}$ to be time variant. In fact we find that

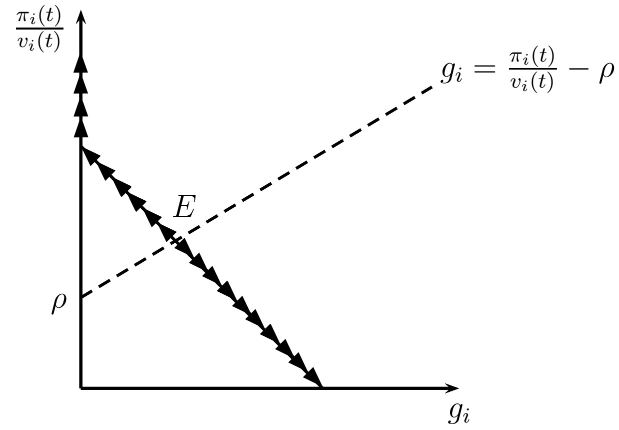
$$g_{\left[\frac{\pi}{v}\right]_i} = -g_i - g_{v,i} = \frac{\pi_i}{v_i} - g_i - \rho \tag{A.3}$$

According to this equation, the ratio $\frac{\pi_i}{v_i}$ can only be constant if

$$g_i = -g_{v,i} \tag{A.4}$$

Our equilibrium can therefore be represented in the following figure:

Figure A.3: Equilibrium with exogenous shares



The full line represents equation (A.2) which must hold in equilibrium. The dashed line in the figure represents the locus of points for which condition (A.4) holds. Arrows show the dynamics that the system follows. Notice that for a given value of $\frac{\pi_i}{v_i}$, if $g_i > \frac{\pi_i}{v_i} - \rho$ then $\frac{\pi_i}{v_i}$ falls until it reaches zero, a situation that can be regarded as infeasible since it implies all resources in the economy are devoted to the development of new products (R&D), but no final goods are being produced. If on the contrary $g_i < \frac{\pi_i}{v_i} - \rho$ then $\frac{\pi_i}{v_i}$ grows until $g_i = 0$. Theoretically nothing prevents diversification rates to be zero. If such situation is reached then (A.2) no longer holds and is replaced by $g_i = 0$. Then, as depicted in the figure, the ratio $\frac{\pi_i}{v_i}$ is free to continue growing indefinitely. We disregard this possibility as is not supported by the empirical evidence presented here.

As a result, stability in this version of the model requires that the economy starts at the intersection of both lines and stays there, meaning the Stability Condition (SC) in (A.4) must hold.

A.5 Allowing S to follow an unstable trajectory

In this section we show that our model is also able to replicate a reversed TTE in a context when the S follows an unstable path. Again, we impose the SC in (20) to N, so the northern economy plays the role of the stable anchor in our model. The full solution for N is exactly the same as that in the previous section: diversification rate in M is constant and equals that in (21), firm profits and value are reduced by exactly that rate and wages and the return rate are constant.

For the S equations (26)-(31) still hold, but as explained in the previous section, the fact that we do not impose the SC in S, implies that the ratio v_A/π_A is not constant and can follow a divergent trajectory. By (10), the value of any firm in sector A (v_A) depends positively on r_S and π_A. We have established that profits in A are decreasing over time, nevertheless the time-path of v_A is also determined by how the return rate evolves over time, a path that is not determined in the model when the SC is not present. Indeed notice that the ratio π_A/v_A can rise or fall, depending on the velocity with which firms' profit in that sector fall and the value of individual's discount factor. How the value of firms in A evolves over time determines the time path of wages in S, since by the FEC we have that $g_{wS} = g_A + g_{vA}$. We can therefore write a condition for wages in S to follow a decreasing trajectory:

$$\frac{\pi_A(t)}{v_A(t)}\left[1+\frac{\sigma_A}{H}\right] > Z \quad \text{if} \quad \frac{H}{1+H} > 0 \qquad (A.5)$$
$$\frac{\pi_A(t)}{v_A(t)}\left[1+\frac{\sigma_A}{H}\right] < Z \quad \text{if} \quad \frac{H}{1+H} < 0$$

with $Z = \frac{L_S}{a_A}\left[\frac{2-\sigma_A}{\sigma_A-1}+\frac{1+H}{H}\right] - \frac{L_N}{a_M}\left[\frac{2-\sigma_M}{\sigma_M-1}\right] - (\sigma_M-1)\frac{\pi_M}{v_M} + \frac{\rho(1+H)}{H}$. Wages in S rise if the previous condition is not met. Notice that, depending on the time path followed by the ratio $\pi_A(t)/v_A(t)$, an outcome in which the condition is met at some point in time and not in another can arise. As we show in the next section, most cases with reasonable parameter values show clear trends for the variables involved, and the condition either holds or not in the long term with no fluctuations for each parametrization.

With aggregate profits falling in S, then decreasing wages represent a sufficient condition for falling income in that region. Notice that both variables are constant in N. The following result summarizes our findings regarding income divergence:

Result A.1 *With endogenous expenditure shares, the model is able to reproduce income divergence. While income is constant in N, in S aggregate firm profits unequivocally fall and the same is true with wages if condition (A.5) is met. Otherwise, wages in S grow and in that case income divergence follows only if the fall in profits is large enough to compensate for rising wages.*

Finally, we can establish a condition for terms of trade in S to be decreasing over time. Notice that equation (7) establishes that the only determinant for changes in relative prices are changes in relative wages. Since wages are constant in N the price of products created there are also time invariant. The price of final production in S evolves following wages in that region and according to our previous result they can fall when condition (A.5) is met. We can easily see that the very requirement for wage divergence is also a necessary and sufficient condition for terms of trade to deteriorate for the South.

Result A.2 *With endogenous expenditure shares to each good, terms of trade can improve or deteriorate for S. They deteriorate if wages in the South fall over time, i.e. condition (A.5) is met. They improve if the opposite happens.*

Notice that a situation of terms of trade falling in S is also one in which aggregate income in that region falls with respect to that in N since we have already established that aggregate profits fall in S. Such a situation constitutes what we call here a reversed TTE, i.e. terms of trade enhancing rather than offsetting income divergence. Result 7 shows that relative prices can improve or deteriorate for the A-sector depending on the speed at which endogenous variables move in our model.