University of Toronto
Department of Economics

Working Paper 817

Aggregate Employment and the Rise of Services across Time and Countries

By Margarida Duarte and Diego Restuccia

January 30, 2026

Aggregate Employment and the Rise of Services across Time and Countries[†]

Margarida Duarte
University of Toronto

Diego Restuccia
University of Toronto
and NBER

January 2026

Abstract

We study the sectoral reallocation of employment over time and across countries, with a focus on the rise of services. We document substantial changes in the ratio of aggregate employment to working-age population across countries that are not systematically related to productivity growth or income levels, yet tightly linked to the rise in services employment. We assess the quantitative contribution of changes in aggregate employment to the rise of services using an otherwise standard model of sectoral reallocation calibrated to time-series for the United States. The calibrated model implies a high elasticity of changes in aggregate employment to services: a one percentage point change in aggregate employment generates on average a 0.7 percentage point change in services employment. The implication is that actual changes in aggregate employment account for one-third of the rise in services, on average across countries, and up to one-half in countries with sustained employment increases.

JEL classification: E1, E24, J11, J16, J21, J22, O11, O41, O51.
Keywords: employment, goods, services, productivity, structural transformation, working-age population.

[†]We thank Duc Nguyen for excellent research assistance. For useful comments and suggestions we also thank Tasso Adamopoulos, Klaus Desmet, Jeremy Greenwood, David Lagakos, Huw Lloyd-Ellis, Rachel Ngai, Sergio Ocampo, Claudia Olivetti, Ömer Özak, Richard Rogerson, Mike Sposi, Gianluca Violante, and event participants at RR65 Conference in Princeton University, Southern Methodist University, McMaster University, Barcelona Summer Forum (Economic Growth and Fluctuations), Deakin University, the 2024 Canadian Economic Association Annual Meeting, and Carleton University. All remaining errors are our own. Restuccia thanks the support from the Canada Research Chairs program and the Bank of Canada Fellowship program. The views expressed herein are not necessarily those of the Bank of Canada and are the authors' alone. *Contact Information:* Department of Economics, University of Toronto, 150 St. George Street, Toronto, ON M5S 3G7, Canada. E-mail: margarida.duarte@utoronto.ca and diego.restuccia@utoronto.ca.

1 Introduction

We study the process of sectoral reallocation of employment over time and across countries, with particular attention to the rise of services. Sectoral shifts can be substantial: in the United States between 1960 and 2000, the employment-to-working-age-population ratio in the services sector increased by 20 percentage points, from 42 to 62 percent. Many other countries experienced similar large movements. While a broad literature emphasizes aggregate productivity growth and sectoral productivity differences as the primary drivers of structural transformation, we highlight a distinct and complementary mechanism: changes in aggregate employment, defined as employment relative to working-age population. Our analysis shows that changes in aggregate employment have a sizeable role in sectoral employment allocations and the evolution of services, over time and across countries.

What is the contribution of changes in aggregate employment to the rise of services over time and across countries? To answer this question, we construct a harmonized dataset combining sectoral employment and value added from the 10-Sector database (Timmer et al., 2015) and the EU-KLEMS database (Van Ark and Jäger, 2017), with population and aggregate income measures from the World Development Indicators (World Bank, 2022) and the Penn World Table (Feenstra et al., 2015). The resulting dataset covers 56 countries spanning the world income distribution, from roughly 1960 to 2010. The data reveal striking heterogeneity in aggregate employment dynamics. In the United States, the aggregate employment ratio increased by 12 percentage points between 1960 to 2000 (from 0.66 to 0.78). Across countries, changes in aggregate employment ratios range from declines of about 15 percentage points to increases of roughly 20 percentage points. We show that aggregate employment dynamics are not systematically related to the level or growth of income per capita, but they are strongly associated with the evolution of services within and across countries.

To interpret these patterns, we consider a standard two-sector general-equilibrium model of sectoral reallocation between goods and services building on Rogerson (2008) that in-

corporates exogenous variation in aggregate employment alongside sectoral productivity growth. The model allows for nonhomotheticities in preferences as well as uneven technological progress across sectors, implying that both income changes and relative price changes can operate and lead to reallocation of labor across sectors. The quantitative importance of the income and relative price channels in driving sectoral reallocation depends critically on the value of preference parameters. To discipline these forces, we calibrate the model to time-series data for the United States and use it to analyze the sectoral implications across countries. The model captures well the sectoral reallocation of employment observed in the United States and across countries.

We quantify the contribution of aggregate employment changes to the rise of services by comparing the sectoral implications of our baseline model with those of the counterfactual in which aggregate employment remains constant at its initial level in each country. We find that the calibrated model implies a high elasticity of services employment to changes in aggregate employment: a one percentage point change in aggregate employment leads to a 0.7 percentage point change in services employment. Importantly, we also show that changes in aggregate employment over time in each country account for one-third of the observed rise in services, on average across countries. This contribution can be as high as 50 percent depending on country-specific dynamics.

In our model, changes in aggregate employment affect income per capita and our results suggest that this source of income variation plays an important role in the sectoral reallocation of labor and the evolution of services over time and across countries. In our dataset, the patterns of aggregate employment over time vary markedly across countries. For example, in the United States aggregate employment grows over time for 4 decades and then declines, in Japan it falls during the sample period, in the Netherlands it declines for 2 decades and then rises for 3 decades. These varied patterns suggest that different forces may be driving aggregate employment in different countries or are operating at different points in time. Accordingly, our analysis abstracts from the specific forces that drive aggregate employment in

each country and instead focuses on quantifying the implications of observed employment changes for sectoral reallocation. We note that in countries where the aggregate employment ratio remains low, future increases in aggregate employment can be a substantial driver of growth in services employment. In contrast, for countries that have already achieved relatively high employment ratios, such as the United States after 2000, this source of sectoral reallocation is bound to play a smaller role or dampen the growth in services employment going forward (Duarte, 2020). We also recognize that, unlike sectoral productivity growth, changes in aggregate employment do not represent a systematic secular source of sectoral reallocation since we have shown several non-monotonic patterns of aggregate employment in the time series of countries and aggregate employment faces a natural bound to employment participation. Nevertheless, our results show that changes in aggregate employment have constituted an important determinant of services employment growth in the cross-country data during our sample period.

Our paper relates to two broad strands of the literature. First, the literature that studies drivers of structural transformation, including Kuznets (1966), Baumol (1967), Kongsamut et al. (2001), Ngai and Pissarides (2007), Acemoglu and Guerrieri (2008), Duarte and Restuccia (2010), Buera and Kaboski (2012), among others. For an excellent and comprehensive review of this literature, see Herrendorf et al. (2014). From this literature we focus on uneven sectoral productivity growth and income effects from non-homothetic preferences. A common abstraction in much of this work is to treat the aggregate supply of labor as fixed. We document large changes in the aggregate employment-to-working-age-population ratio across countries and over time, changes that are not systematically connected to the level of development or to productivity growth, and show that these movements are strongly associated with the evolution of service-sector employment. Second, the literature on the evolution of aggregate employment such as Prescott (2004), Rogerson (2008), Ngai and Pissarides (2008), Ngai and Petrongolo (2017), Bick et al. (2022), Duarte (2020), among others. This literature focuses on individual drivers of aggregate employment in specific contexts. We differ

from these studies by emphasizing a direct driver of employment reallocation: changes in aggregate employment not connected with the process of development and improvements in technology; and focus on the impact of this driver on the sectoral reallocation experiences across time and countries.

Our work most closely connects to that of Rogerson (2008) considering the role of productivity catch up and the increase in taxes in Europe relative to the United States as important drivers of both the decline in market hours of work in Europe relative to the United States and the more muted increase in market services in Europe. Our analysis quantifies the direct effect of market employment on the reallocation to services across a broad set of countries with varied aggregate employment experiences. While changes in taxes may be responsible for some of the changes in aggregate employment we document, we have shown heterogeneous paths in this measure that are unlikely explained by an individual source. Moreover, we focus on quantifying the direct contribution of changes in aggregate employment (whichever its source) on the rise of services for a broad set of countries. Our work also closely relates to Ngai and Petrongolo (2017) considering the role of slower productivity growth in services relative to goods and women's comparative advantage in service production as important drivers of the rise in female labor force participation and the rise of services in the United States. We complement their work by quantifying the direct effect of broad changes in aggregate employment on the rise of services across many countries. Our cross-country data indicates that for many countries changes in aggregate employment are driven by both genders and even for the United States after 2000 the decline in aggregate employment is driven mostly by declines in men's employment. We find that regardless of the source of changes in aggregate employment, they have contributed substantially (about one-third on average) to the evolution of services employment during our sample period.

The paper is organized as follows. Section 2 documents the empirical evidence on aggregate and sectoral employment patterns across a large set of countries. Section 3 presents the model of structural transformation, describes its calibration to data for the United States,

and assesses its performance in capturing the observed changes in sectoral employment allocations across countries. Section 4 uses the model to assess the quantitative role of changes in aggregate employment for the rise in services employment across countries. Section 5 concludes.

2 Empirical Evidence

We describe the construction of our dataset, including the sources of data and variable definitions, and discuss a set of facts about employment across sectors, countries and time. These facts motivate the quantitative analysis that follows.

2.1 Data Description

Our dataset combines data from several sources. We obtain data on employment and real value added by sector from the 10-Sector database (Timmer et al., 2015) for most countries in our sample and the EU-KLEMS dataset (Van Ark and Jäger, 2017) for some countries; data on working-age population (15-64 year old) from the World Development Indicators database (World Bank, 2022); and data on real GDP per capita and real GDP per worker from the Penn World Table (PWTv10.0) (Feenstra et al., 2015). We also report data on employment by gender from ILOSTAT database (International Labour Organization, 2022). The final dataset comprises 56 countries spanning a substantial portion of the cross-country income per capita distribution, roughly over the period between 1960 and 2010. For countries in the EU-KLEMS dataset, the covered period is 1970 to 2007. Data on employment by gender from ILOSTAT is restricted to the period 1991 to 2007. We note though that the starting and ending date of time series vary slightly across variables and countries.

In the 10-Sector and EU-KLEMS databases, employment refers to persons engaged, which includes employees, self-employed, and family workers. The data rely on population censuses

as well as labor force surveys and business surveys to maximize comparability across time and space. The data for real value added are taken from national accounts and is considered to be of high quality. We aggregate the detailed sectoral employment and value-added data into two broad categories, goods and services, and focus our analysis on this sectoral decomposition (see Appendix A for details). We use the same data source and decomposition to calculate real value added per worker in the goods and services sectors for all the countries in our sample, where real refers to constant domestic price over time in each country.

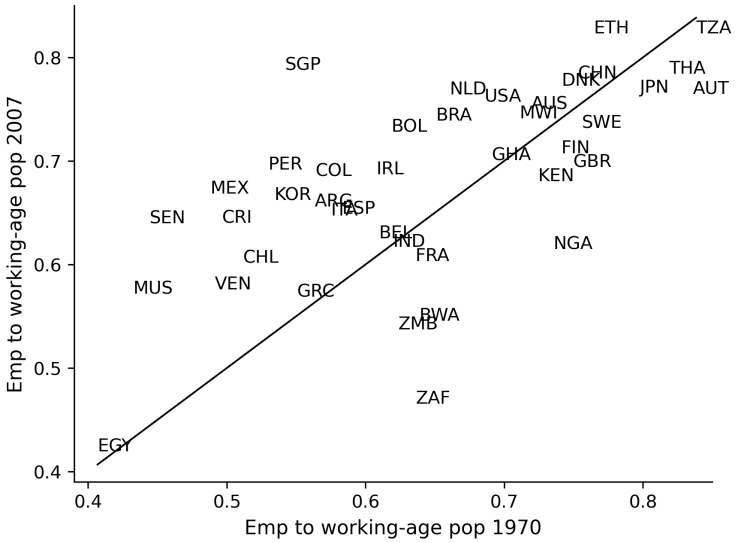
2.2 Observations

We emphasize the following two facts. First, there are substantial changes over time in the aggregate employment to working-age population across countries and these changes are not systematically related to the level of income per capita or its growth. Second, changes in aggregate employment to working-age population are strongly associated with changes in services employment to working-age population across countries.

Changes in aggregate employment. We start by describing the changes in the employment to working-age population ratio across countries in our sample. In what follows, unless otherwise noted, we refer to the aggregate employment to working-age population ratio as the employment ratio or aggregate employment interchangeably. Figure 1 documents the employment ratio in 1970 against the employment ratio in 2007 for the 41 countries in our dataset with sectoral employment data over this period. We report the period 1970 to 2007 in this figure, however, a similar pattern of variation arises when focusing on the 1960 to 2010 period for a slightly smaller subset of countries.

Figure 1 shows both the wide differences in employment ratios across countries and the variation in this ratio over time (Rogerson, 2001, 2006). For instance, in 1970 the employment ratio was as low as 40 percent in Egypt and as high as 85 percent in Tanzania, whereas in the

Figure 1: Aggregate Employment to Working-Age Population across Countries

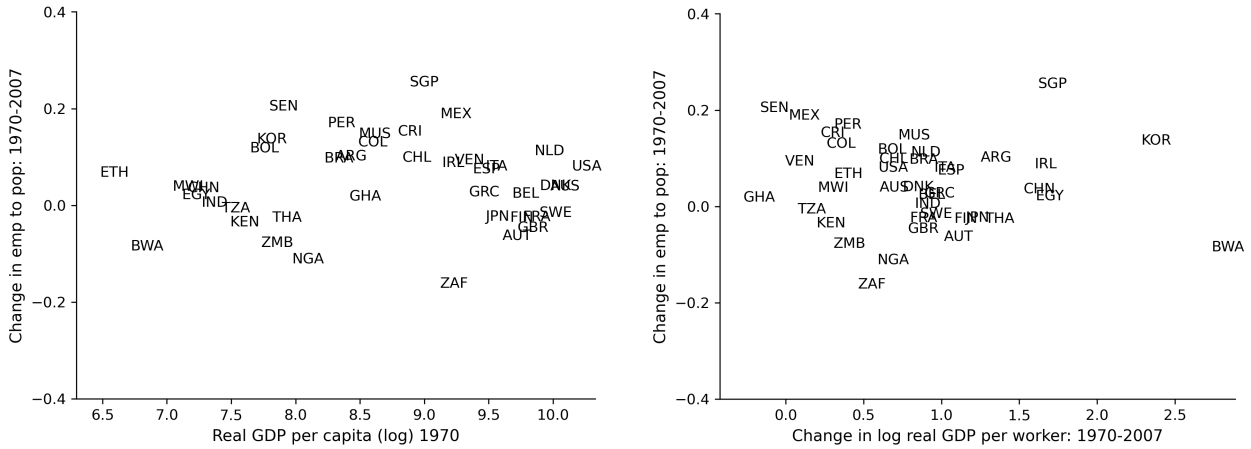


Notes: Aggregate employment to working-age population ratio across countries for 1970 and 2007. The solid line is the 45 degree line where the values in the x-axis and y-axis are the same.

United States this ratio was close to 70 percent. By 2007, the employment ratio was roughly the same as in 1970 for several countries such as Egypt, Belgium, and Denmark; declined by 5 percentage points or more for several countries such as South Africa, Zimbabwe, Nigeria, and Austria; and strongly increased for most other countries, increasing by more than 10 percentage points for several countries such as Senegal, Mexico, Peru, and the Netherlands.

Consistent with well-known development facts, aggregate employment differences are not systematically related with the level of development. More importantly for our analysis, we find that changes in aggregate employment across countries are not systematically related to the level of real GDP per capita or growth in real GDP per worker (aggregate labor productivity). Figure 2 documents the lack of systematic relationship across countries between changes in aggregate employment between 1970 and 2007 and real GDP per capita in 1970 (left panel) and the growth in aggregate labor productivity between 1970 and 2007 (right panel). The correlation coefficient between changes in aggregate employment and the level of income per capita is 0.02, whereas with growth in aggregate labor productivity is slightly negative (-0.11).

Figure 2: Changes in Aggregate Employment, Income per Capita, and Growth

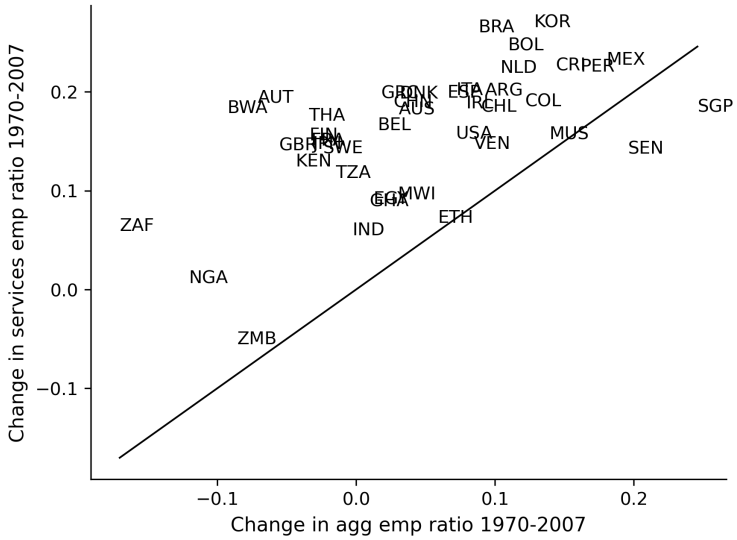


Notes: Relationship between changes in the aggregate employment ratio and the level of development (real GDP per capita) in the left panel and growth in aggregate labor productivity in the right panel.

Aggregate employment and services. Changes in aggregate employment are strongly related to changes in employment in services across countries. Figure 3 documents the change in the employment ratio between 1970 and 2007 and the corresponding change in employment in services. Figure 3 illustrates that countries with substantial increases in the aggregate employment ratio show a disproportionate reallocation of employment towards services, whereas countries with no increase or a decline in the aggregate employment ratio show weak or no sectoral reallocation. While the employment ratio in services rises in most countries, it rises disproportionally more in countries where the aggregate employment ratio increases.

The evidence from time series of individual countries suggests a clear stronger (weaker) reallocation of labor towards services in countries where aggregate employment increased (decreased). Figure 4 shows the evolution of aggregate and sectoral employment ratios in four countries: Chile (CHL), Spain (ESP), Mexico (MEX), and the Netherlands (NLD). In all these countries we observe episodes of either stable or declining aggregate employment followed by a strongly rising aggregate employment, which are associated with relatively minor reallocation of employment to services followed by strongly increasing reallocation to

Figure 3: Changes in Aggregate Employment and the Evolution of Services across Countries

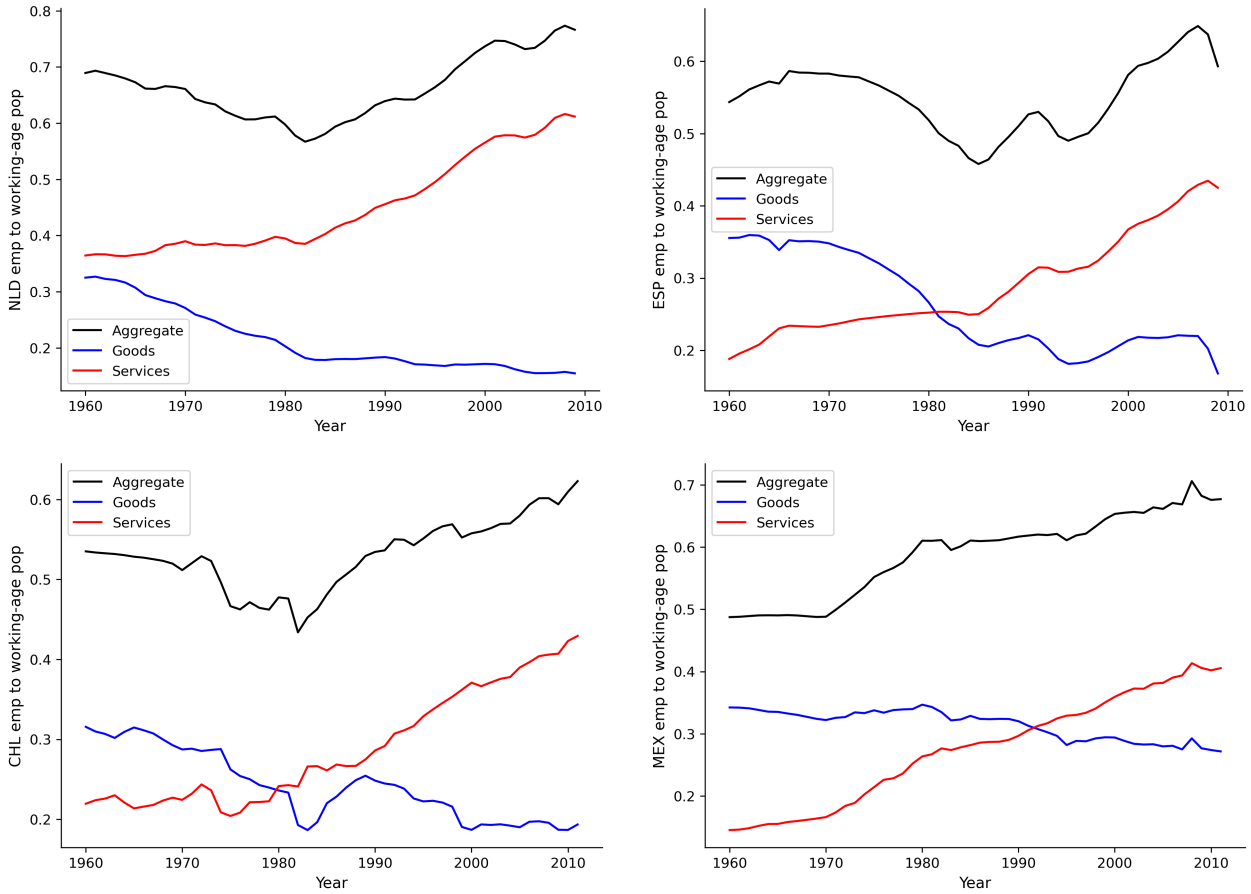


Notes: Changes in the aggregate employment ratio and changes in services employment to working age population between 1970 and 2007 across countries. The solid line is the 45 degree line where the values in the x-axis and y-axis are the same.

services. This evidence is suggestive of the connection between the strength of changes in aggregate employment and the extent of reallocation of employment to services.

The literature on the process of structural transformation (e.g., Kongsamut et al., 2001; Baumol, 1967; Ngai and Pissarides, 2007, among others) emphasizes the role of income and substitution effects implied by sectoral and aggregate productivity growth in driving the rise of the employment share in services. But the evidence suggests that services rise disproportionally more in countries where aggregate employment rises and that this rise is not systematically related to the level of income per capita or growth in aggregate labor productivity. In the next section, we use a standard quantitative model of structural transformation to disentangle the role of changes in aggregate employment and the role of traditional forces of structural change such as sectoral and aggregate productivity growth in understanding sectoral labor reallocation, and in particular the rise of services, over time and across countries.

Figure 4: Aggregate Employment and Services over Time, Some Countries

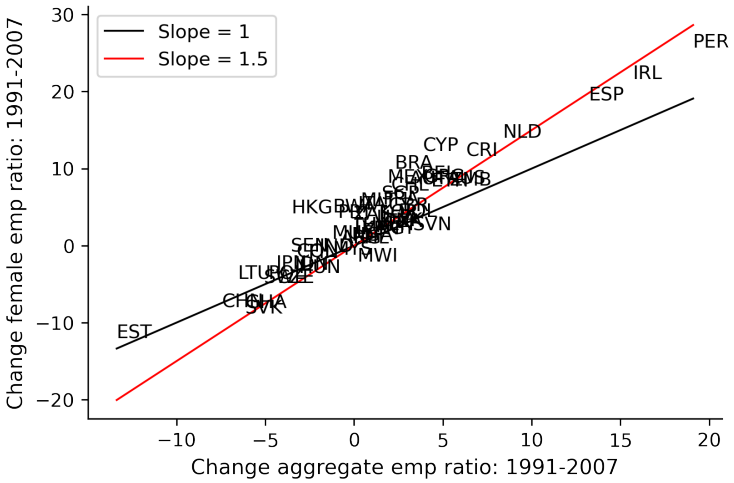


Notes: The evolution over time of the aggregate employment to working-age population and its sectoral composition for some countries.

Role of female employment. A natural question that arises is what drives the documented changes in aggregate employment across countries. We have noted that changes in aggregate employment are not systematically related with the level of development or growth in aggregate labor productivity. An important feature in many countries appears to be the increase in female labor force participation, potentially associated with declining barriers to female employment across countries, as suggested at least by the evidence in Hsieh et al. (2019) regarding changes in gender barriers in the United States. Ngai and Petrongolo (2017) emphasize the role of structural transformation and marketization of services on female labor market outcomes in the United States. Duarte (2020) documents the

evolution of employment ratios in the United States—both aggregate and by gender—since 1960, showing that the rising aggregate employment through 2000 is largely explained by the convergence of female to male employment. After 2000, however, the convergence of female employment in the United States stalls at about 85 percent of male employment (see also Fukui et al., 2018). Nevertheless, we emphasize that for many countries we observe decreases in aggregate employment, suggesting other sources of variation over time such as changes in taxes that are important in understanding the evolution of employment in Europe relative to the United States (Prescott, 2004; Rogerson, 2008).

Figure 5: Changes in Female and Aggregate Employment across Countries



Notes: Changes in the aggregate employment ratio and changes in female employment ratio between 1991 and 2007 across countries. The solid black line is the 45 degree line where the values in the x-axis and y-axis are the same, whereas the dashed red line represents the 1.5 slope where changes in the y-axis are 50% larger than changes in the x-axis.

Using our dataset, Figure 5 documents the change in the aggregate employment ratio against the change in the female employment ratio (measured as female employment relative to the female working-age population) across countries between 1991 and 2007. The time period and sample of countries in this figure differ slightly from our baseline sample, as the female employment data are drawn from the ILO database, which is unavailable for some countries or for years prior to 1991. For many countries, the observed changes lie close to the 45-degree line, indicating that the change in female employment closely mirrors that of males.

In contrast, countries that experienced larger increases in female employment tend to fall near the line with a slope of 1.5, suggesting that growth in female employment is the main driver of aggregate employment gains. Finally, note that in the subset of countries where female employment declined, the decline is shared by men as well.

3 Model

We consider a standard general-equilibrium model of sectoral reallocation building on Rogerson (2008) and Duarte and Restuccia (2010). At each date, two commodities—goods and services—are produced with linear technologies on the labor input. Employment reallocation across sectors is driven by relative price effects that arise from differential sectoral productivity growth and by income effects due to non-homothetic preferences. In our model, income per capita grows over time with sectoral productivity growth and it varies with changes in aggregate employment, altering the strength of the income effect.

We show that changes in aggregate employment play an important quantitative role in understanding the sectoral reallocation of labor over time and across countries. To do so, we calibrate the model to data for the United States, providing discipline to the economic forces in the model. We show that data on sectoral productivity growth and changes in aggregate employment generate changes in sectoral employment allocations consistent with cross-country observations. We then use the model to quantify the contribution of changes in aggregate employment on the reallocation of employment across sectors.

3.1 Description

Production. In each period, two commodities—goods (g) and services (s)—are produced according to the following constant returns to scale production functions:

$$Y_i = A_i L_i, \qquad i \in \{g, s\}, \tag{1}$$

where Y_i is output in sector i, L_i is labor input in sector i, and A_i is a sector-specific technology parameter. The parameter A_i maps to sectoral labor productivity in the data. We abstract from the specific sources of variation in A_i (for instance, changes in sectoral total factor productivity, capital intensity, or misallocation) as the sources of variation are not critical for our analysis and we are also limited by capital stock data across sectors and countries.

Households. The economy is populated by an infinitely-lived representative household of constant size. The household is endowed with L units of time each period, supplied inelastically to the market. We follow Comin et al. (2021) and assume that the household has non-homothetic CES preferences over goods and services, given implicitly by:

$$\left[(1-a)^{\frac{1}{\sigma}}\left(\frac{c_g}{C^{\epsilon_g}}\right)^{\frac{\sigma-1}{\sigma}} + a^{\frac{1}{\sigma}}\left(\frac{c_s}{C^{\epsilon_s}}\right)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} = 1,$$

where a is a preference weight, $\sigma > 0$ controls the elasticity of substitution between goods and services, and $\epsilon_i > 0$ controls the income elasticity of consumption in each sector. Note that when $\epsilon_i = 1$, this function becomes a standard CES utility aggregator of goods and services consumption, and changes in income do not affect sectoral expenditure shares. When $\sigma = 1$ this function simplifies further to a standard Cobb-Douglas utility aggregator with weights a and $(1-a)$ for services and goods. In this case, sectoral expenditure shares are not affected by changes in relative prices or income. As a result, the values of σ and ϵ_i determine the

strength of the income and substitution effects driving the reallocation of activity between the two sectors.

Market structure. We assume a continuum of homogeneous firms in each sector that are perfectly competitive in output and factor markets. At each date, given the price of commodity i, p_i, and wage rate w, a representative firm in sector i chooses the labor input to maximize profits. The household chooses consumption allocations to maximize utility subject to the budget constraint,

$$p_g c_g + p_s c_s = wL,$$

taking prices and the wage rate as given. Note that both productivity growth and changes in aggregate employment L affect income per capita and hence reallocation of employment across sectors, however, changes in aggregate employment as a source of income effects are usually abstracted from in studies of structural transformation.

Equilibrium. The model is a sequence of static employment allocation problems. Market clearing implies that

$$c_g = A_g L_g, \quad c_s = A_s L_s, \quad L = L_g + L_s.$$

Normalizing the wage rate to 1, the firms' problem implies that prices are given each period by

$$p_i = \frac{1}{A_i}, \qquad i \in \{g, s\}. \tag{2}$$

The first-order conditions for the household problem, together with equilibrium prices and market clearing, imply that the sectoral allocation of labor is given by:

$$\frac{L_s}{L_g} = \frac{p_s c_s}{p_g c_g} = \frac{a}{(1-a)} \left(\frac{p_s}{p_g}\right)^{1-\sigma} C^{(\epsilon_s - \epsilon_g)(1-\sigma)},$$

where the ratio of employment across sectors is equal to the ratio of consumption expenditures and depends on demand weights, the relative price, and the level of consumption. Sectoral labor reallocation follows from changes in the relative price (substitution effects) when $\sigma \neq 1$ and from changes in aggregate consumption (income effects) when $\epsilon_s \neq \epsilon_g$. Note that only the relative sectoral income effect $(\epsilon_s - \epsilon_g)$ matters for the allocation of labor, and we denote $\epsilon = \epsilon_s - \epsilon_g$ as the relevant parameter to restrict. The qualitative implications of substitution and income effects in our framework are similar to those emphasized in the structural transformation literature (e.g., Echevarria, 1997; Kongsamut et al., 2001; Ngai and Pissarides, 2007), the non-homothetic CES specification provides more flexibility for the quantitative analysis across countries explored below. Nevertheless, we note that our quantitative results are similar if instead we consider standard generalized Stone-Geary preferences as in Rogerson (2008) and Herrendorf et al. (2014).

3.2 Calibration

United States. We calibrate the parameters of the model to match the process of sectoral reallocation in the United States, given exogenous average sectoral productivity growth rates γ_i over time and time series for aggregate employment L_t.

We obtain labor productivity in each sector from data on real value added and employment and filter labor productivity series using the Hodrick-Prescott filter to focus on secular changes. We calculate the average growth rates of labor productivity in each sector, γ_i, and the time path for sectoral labor productivity follows as

$$A_{i,t+1} = (1 + \gamma_i)A_{i,t}, \qquad i \in \{g, s\},$$

with $A_{i,ini}$ normalized to one in 1960. We note that our results are similar if instead we use year-to-year growth rates rather than the average growth rate.

We map L_t to the aggregate employment to working-age population ratio in the data. We set $\sigma = 0.1$ consistent with complementarity between goods and services as estimated in the literature (Comin et al., 2021; Sposi et al., 2021). We then calibrate ϵ and a to match the sectoral employment ratios in 1960 and 2000. The calibrated $\epsilon = 1$ is also within the ranges estimated in the literature. Table 1 reports the calibrated parameter values.

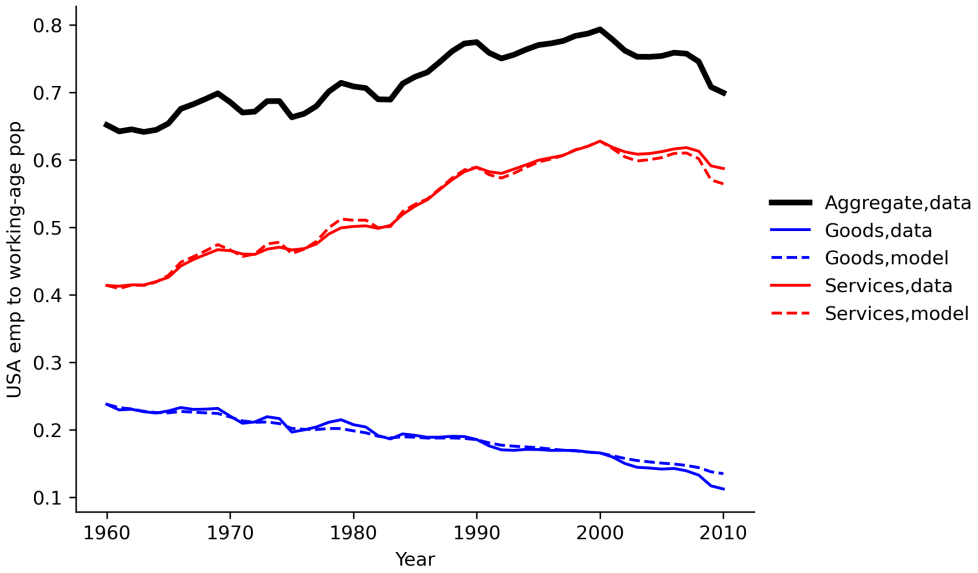
Table 1: Calibration to Data for the United States

Parameter	Value	Target from U.S. data
$A_{i,ini}$	1.0	Normalization
γ_g	{data (2.4%)}	Average labor productivity growth in goods
γ_s	{data (1.5%)}	Average labor productivity growth in services
L_t	{data}	Aggregate employment ratio
σ	0.10	Complementarity, consistent with estimates in literature
ϵ	1	Sectoral employment ratios 1960, 2000
a	0.68	Sectoral employment ratios 1960, 2000

Figure 6 reports the employment ratios in goods and services implied by the model (dashed lines) and in the data (solid lines), alongside the aggregate employment ratio. Given constant sectoral labor productivity growth and changes in the aggregate employment ratio, the model captures well the reallocation of employment from goods to services observed in the United States during this period. Despite its simplicity and assumed constant sectoral growth rates, overall the model does a good job capturing year-by-year changes in the sectoral ratios.

Cross-country analysis. We assume that all countries in our sample share the same preference parameters (a, σ, and ϵ) as the United States. Countries differ in the levels of initial sectoral productivity, average sectoral productivity growth rates, and aggregate employment ratio. For each country, the aggregate employment ratio (L_t) and the average sectoral productivity growth rates (γ_i) are obtained directly from the country's data. For each country, we also calibrate the level of the two initial sectoral labor productivities, $A_{i,ini}$, to match the employment ratio in goods and aggregate labor productivity relative to that

Figure 6: Aggregate and Sectoral employment ratios, United States



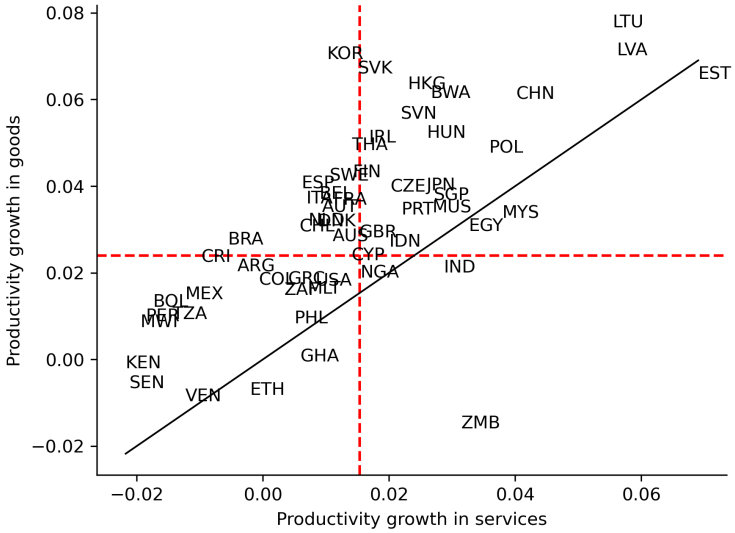
Notes: Aggregate and sectoral employment to working-age population ratios for the United States. Solid lines represent the data and dashed lines the quantitative model.

of the United States in the initial period. Note that the calibration for the United States implies that the model matches the U.S. sectoral allocation of labor in 1960 and 2000. In contrast, the cross-country analysis implies that the model matches the country's sectoral allocation of labor in the initial period only.

Figure 7 documents the average labor productivity growth rates in goods and services for the countries in our dataset, with the dashed red lines indicating the sectoral growth rates of the United States as reference. As emphasized in Duarte and Restuccia (2010), for most countries in our sample, productivity growth rates are higher in goods than in services and there is substantial variation in growth rates across countries.

Results. We now describe how the model performs in terms of generating the reallocation of labor across sectors given the country-specific growth rates and changes in aggregate employment. Figure 8 summarizes the performance of the model in capturing the reallocation of employment across sectors in all countries by reporting the employment ratio in services

Figure 7: Sectoral Labor Productivity Growth across Countries



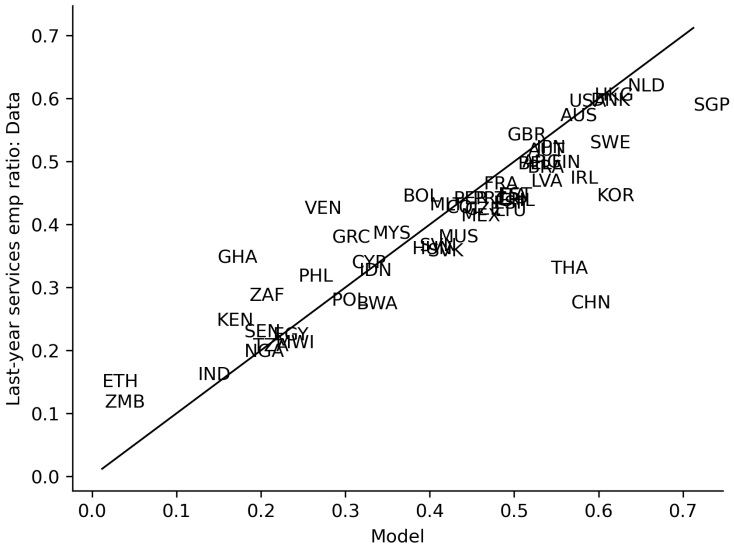
Notes: Average annual labor productivity growth in each sector across countries. Dashed red lines represent the values for the United States whereas the solid black line is the 45 degree line where the values in the x-axis and y-axis are the same.

in the last year in the sample for all countries in the data and the model. The solid line represents the 45 degree line where model and data exactly line up.

Figure 8 illustrates that the model is able to broadly capture the reallocation of employment towards services in most countries, with China, Korea, Thailand, and Singapore being somewhat outliers in the weak reallocation to services in the data compared to the model. These deviations are likely due to these countries featuring substantial productivity growth in manufacturing and production of manufacturing goods for exports, a consideration abstracted from in our framework.

We also document the performance of the model in terms of the reallocation of employment over time for some countries. Figure 9 documents the aggregate and sectoral employment to working-age population ratios in the model and data for Colombia, Poland, Japan and the Netherlands. We emphasize from these examples that the model performs well in accounting for the process of labor reallocation across sectors even in countries with different and changing patterns in the aggregate employment ratio.

Figure 8: Services Employment Ratio across Countries in the last Period



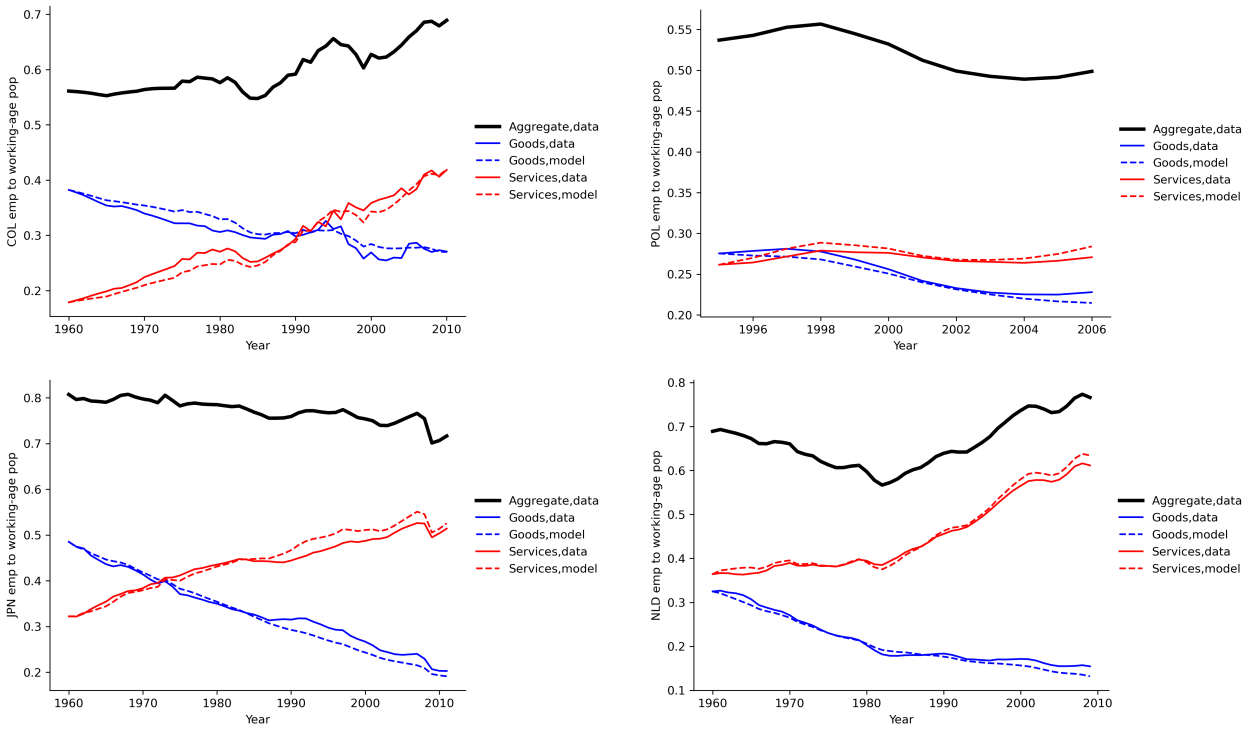
Notes: Services employment to working-age population across countries in the last period, model in the x-axis versus data in the y-axis. The solid black line is the 45 degree line where the values in the x-axis and y-axis are the same.

4 The Role of Aggregate Employment

To isolate the role of changes in aggregate employment on the rise of services, we perform the following counterfactual experiment. For each country, we hold aggregate employment fixed at its initial level ($L_t = L_{ini}$), and compute the model's implied employment ratios across sectors. In this counterfactual experiment, changes over time in the aggregate employment ratio are eliminated and, as a result, the difference between the baseline model and the counterfactual represents a measure of the contribution of changes in aggregate employment on sectoral reallocation.

Aggregate employment and services. Our first key result is that the calibrated model implies a high elasticity of changes in aggregate employment on services employment. Specifically, a 1 percentage point change in aggregate employment translates into a 0.7 percentage point change in services employment across countries. Figure 10 illustrates this result by plot-

Figure 9: Employment Ratios over Time in the Model and Data, Some Countries

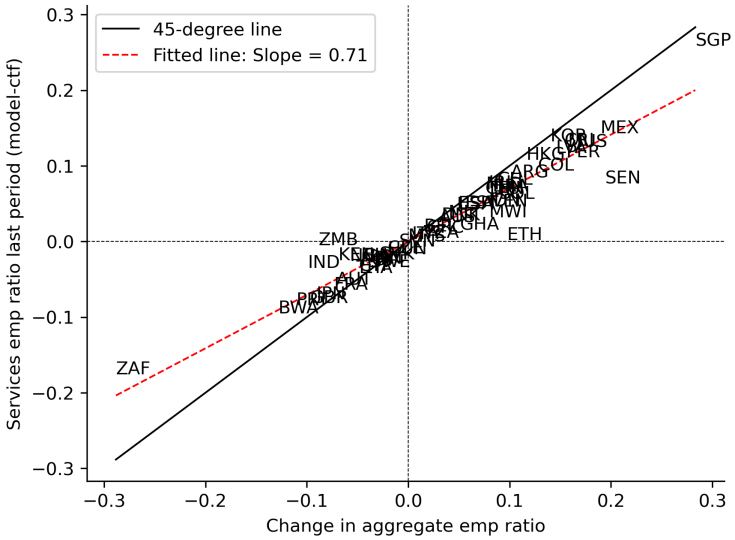


Notes: Aggregate and sectoral employment to working-age population ratios for some countries. Solid lines represent the data and dashed lines the quantitative model.

ting each country's the change in aggregate employment against the model-implied change in services employment attributable to changes in aggregate employment (i.e., the difference in services employment in the baseline and counterfactual model in the final period).

If aggregate employment has no effect on the sectoral allocation, there would be no difference in services employment between the model and the counterfactual, and all countries would lie along the horizontal line. Conversely, if changes in aggregate employment translate fully into service-sector employment, all countries would align along the 45-degree line. Our calibrated model implies that a one percentage point (p.p.) change in aggregate employment generates on average a 0.7 p.p. change in employment in services, as illustrated by the dashed red line in Figure 10. We show in Appendix B that in the context of standard Generalized Stone Geary preferences the elasticity of aggregate employment on services employment can be solved analytically and shown to depend on calibrated preference parameters and sectoral

Figure 10: Aggregate Employment and Services

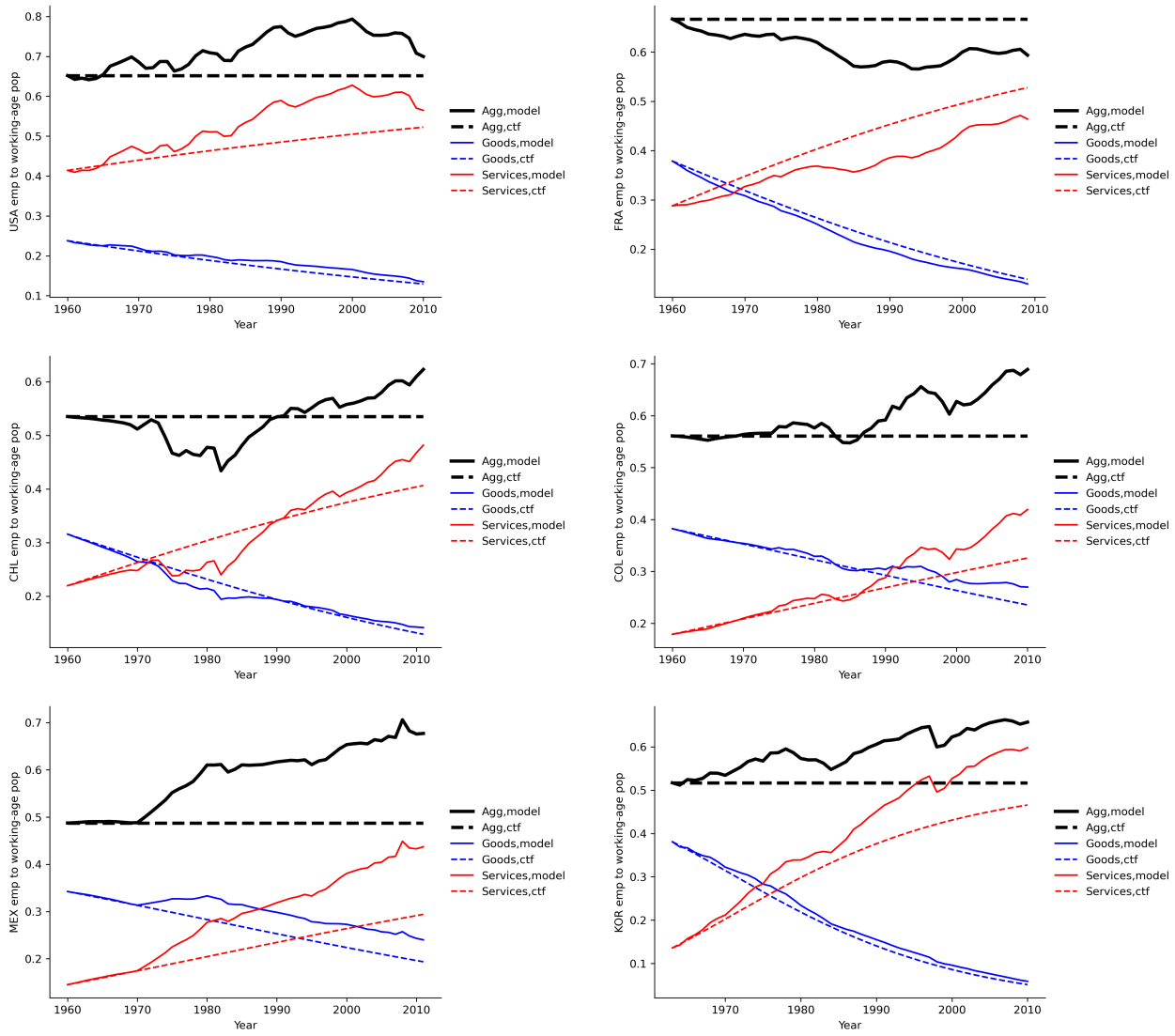


Notes: Change in aggregate employment ratio over sample period in the x-axis versus difference in services employment ratio between the model and the counterfactual in the last period in the y-axis. The solid black line is the 45 degree line where the values in the x-axis and y-axis are the same and the dotted red line is the fitted line.

productivity growth, which delivers a slightly larger elasticity than in our baseline calibration with non-homothetic CES preferences.

We further illustrate this result over time for individual countries. Figure 11 documents the model and counterfactual sectoral allocations for some countries with varied patterns for aggregate employment, including the United States, France, Chile, Colombia, Mexico, and Korea. In the United States, the increase in aggregate employment accounts for roughly two-thirds of the rise in services employment up to 2000, and most of the subsequent slowdown, a result emphasized in Duarte (2020). In France, the decline in aggregate employment accounts for the slow rise in services, consistent with the findings in Rogerson (2008). In Chile and Colombia, periods of declining or stagnant aggregate employment followed by sharp increases account for the acceleration in the service employment ratio. Finally, in Mexico and Korea, strong and sustained increases in aggregate employment account for substantial expansions in services employment.

Figure 11: Cross-country counterfactual results–some countries



Notes: Aggregate and sectoral employment to working-age population ratios for some countries. Solid lines represent the baseline model and dashed lines the counterfactual with constant aggregate employment.

The role of aggregate employment on the rise of services. Our previous result summarizes how much of the change in aggregate employment translates into changes in services employment. We now characterize how much the change in services due to the change in aggregate employment accounts for the overall change in services employment. Recall that services employment also raises with the pattern of sectoral productivity growth. We note that characterizing the effect of changes in aggregate employment in the cross-country data is difficult because the time series of aggregate employment in many countries is non-monotone; within a country time series there are periods of declining, constant, or increasing aggregate employment. We nevertheless provide some summary statistics on the overall contribution and for some countries for in which the aggregate employment increases more systematically over the sample period.

Column (1) in Table 2 reports the average overall change in the aggregate employment ratio between the initial and final period in our sample, separately for countries with positive and negative net changes, and for some individual countries such as the United States until 2000, Mexico, and Peru. On average, the increase in the aggregate employment ratio is 9 p.p. for countries with positive net changes and -7 p.p. for countries with negative changes in our sample.

Column (2) reports the average model-implied change in services employment attributable to changes in aggregate employment, computed as the difference between the baseline model and the counterfactual with constant aggregate employment. The average contribution is 7 p.p. for countries with positive net changes and -5 p.p. for countries with negative changes. As noted previously, the change in services due to changes in aggregate employment is about 70 percent on average for either set of countries.

Column (3) reports the total change in services employment in the baseline model. Services employment increased by 21 p.p. in countries with positive net changes in aggregate employment and only 10 p.p. in countries with negative net changes. Hence, changes in aggregate

Table 2: Changes in Aggregate Employment and the Rise of Services

	(1) $\Delta(E/P)$	(2) $\Delta(E_s/P)$ due to $\Delta(E/P)$	(3) $\Delta(E_s/P)$
Countries with $\Delta(E/P) > 0$	0.09	0.07	0.21
– United States (USA 2000)	0.14	0.12	0.21
– Mexico (MEX)	0.19	0.14	0.29
– Peru (PER)	0.16	0.11	0.27
Countries with $\Delta(E/P) < 0$	−0.07	−0.05	0.10

Notes: Changes in percentage points. Column (1) reports the change in the aggregate employment to working-age population ratio ($\Delta(E/P)$) in the sample period, column (2) reports the change in services employment ratio due to the change in aggregate employment ($\Delta(E_s/P)$ due to $\Delta(E_s/P)$) from the difference between model and model counterfactual with constant aggregate employment, column (3) reports the change in services employment ratio in the model ($\Delta(E_s/P)$) in the sample period. The table reports some countries, and averages for countries with positive changes in aggregate employment and negative changes during the sample period. USA 2000 refers to the case of the United States from 1960 to 2000, a period of substantial increase in the aggregate employment ratio.

employment account for one-third of the rise in services: 0.07/0.21 for countries with positive net changes in aggregate employment and 0.05/0.15 for countries with negative net changes. We note that this is an average contribution, the effect is larger for countries with a more systematic increase in the aggregate employment ratio over the sample period. To highlight this effect, we include in Table 2 three countries where aggregate employment rises more systematically during the sample period. In the United States, the aggregate employment ratio increases by 14 p.p. between 1960 and 2000, contributing to a 12 p.p. increase in services employment, which accounts for around 57% (0.12/0.21) of the overall increase in services employment of 21 p.p. during this period. For Mexico, the contribution of the change in aggregate employment to services accounts for almost half the actual increase in services (0.14/0.29), whereas for Peru this contribution is about 40% (0.11/0.27).

Overall, we conclude that changes in aggregate employment across countries are a substantial driver of the rise in services across countries in our sample period.

5 Conclusion

We document substantial changes over time in the ratio of aggregate employment to working-age population across a large set of countries, changes that are not systematically related with the level of development or with labor productivity growth. We use a standard model of sectoral reallocation calibrated to U.S. data to quantify the role of changes in aggregate employment on the rise of services across countries. The calibrated model implies a high elasticity of changes in aggregate employment on services employment: a one percentage point change in aggregate employment translates into about 0.7 percentage point change in services employment. We find that, across countries, changes in aggregate employment account for at least one-third of the rise in services and about one-half in countries with systematic increases in aggregate employment during the sample period. These results are robust to different specifications of preferences.

Our analysis implies that changes in aggregate employment, through their impact on the income per capita, can be a substantial driver of sectoral reallocation to services. This mechanism can be especially relevant for countries with low employment ratios—for instance, due to lower female labor-force participation—where increases in aggregate employment can provide a substantial source of reallocation to services. By contrast, for countries that have already achieved relatively high employment ratios, such as the United States after 2000, this source of sectoral reallocation is bound to play a smaller role or dampen the growth in services employment going forward. Our analysis abstracts from the source of changes in aggregate employment because these sources likely differ across countries. Nevertheless, identifying and understanding the underlying drivers of changes in aggregate employment, such as declining barriers to female employment participation (Hsieh et al., 2019) or varying labor income taxes (Rogerson, 2008), is important and can provide direct guidance to policy. We leave these essential explorations for future research.

References

Acemoglu, D. and Guerrieri, V. (2008). Capital deepening and nonbalanced economic growth. *Journal of political Economy*, 116(3):467–498.

Baumol, W. J. (1967). Macroeconomics of unbalanced growth: the anatomy of urban crisis. *The American economic review*, 57(3):415–426.

Bick, A., Fuchs-Schündeln, N., Lagakos, D., and Tsujiyama, H. (2022). Structural change in labor supply and cross-country differences in hours worked. *Journal of Monetary Economics*, 130:68–85.

Buera, F. J. and Kaboski, J. (2012). The rise of the service economy. *The American Economic Review*, 102(6):2540–2569.

Comin, D., Lashkari, D., and Mestieri, M. (2021). Structural change with long-run income and price effects. *Econometrica*, 89(1):311–374.

Duarte, M. (2020). Services and the decline of the us employment-to-population ratio. Technical report, University of Toronto, Department of Economics.

Duarte, M. and Restuccia, D. (2010). The role of the structural transformation in aggregate productivity. *The Quarterly Journal of Economics*, 125(1):129–173.

Duarte, M. and Restuccia, D. (2020). Relative prices and sectoral productivity. *Journal of the European Economic Association*, 18(3):1400–1443.

Echevarria, C. (1997). Changes in sectoral composition associated with economic growth. *International Economic Review*, pages 431–452.

Feenstra, R. C., Inklaar, R., and Timmer, M. P. (2015). The next generation of the penn world table. *American economic review*, 105(10):3150–82.

Fukui, M., Nakamura, E., and Steinsson, J. (2018). Women, wealth effects, and slow recoveries.

Herrendorf, B., Rogerson, R., and Valentinyi, Á. (2014). Growth and structural transformation. *Handbook of Economic Growth*, 2:855–941.

Herrendorf, B., Rogerson, R., and Valentinyi, Á. (2022). New evidence on sectoral labor productivity: implications for industrialization and development. Technical report, National Bureau of Economic Research.

Hsieh, C.-T., Hurst, E., Jones, C. I., and Klenow, P. J. (2019). The allocation of talent and us economic growth. *Econometrica*, 87(5):1439–1474.

International Labour Organization (2022). Ilo modelled estimates database, ilostat [database]. https://ilostat.ilo.org/data/, accessed December 10, 2022.

Kongsamut, P., Rebelo, S., and Xie, D. (2001). Beyond balanced growth. *The Review of Economic Studies*, 68(4):869–882.

Kuznets, S. S. (1966). *Modern economic growth*. Yale University Press.

Ngai, L. R. and Petrongolo, B. (2017). Gender gaps and the rise of the service economy. *American Economic Journal: Macroeconomics*, 9(4):1–44.

Ngai, L. R. and Pissarides, C. A. (2007). Structural change in a multisector model of growth. *The American Economic Review*, 97(1):429–443.

Ngai, L. R. and Pissarides, C. A. (2008). Trends in hours and economic growth. *Review of Economic Dynamics*, 11(2):239–256.

Prescott, E. C. (2004). Why do americans work so much more than europeans?

Restuccia, D., Yang, D. T., and Zhu, X. (2008). Agriculture and aggregate productivity: A quantitative cross-country analysis. *Journal of monetary economics*, 55(2):234–250.

Rogerson, R. (2001). The employment of nations–a primer. *Economic Review-Federal Reserve Bank of Cleveland*, 37(4):27–50.

Rogerson, R. (2006). Understanding differences in hours worked. *Review of Economic dynamics*, 9(3):365–409.

Rogerson, R. (2008). Structural transformation and the deterioration of european labor market outcomes. *Journal of Political Economy*, 116(2):235–259.

Sposi, M., Yi, K.-M., and Zhang, J. (2021). Deindustrialization and industry polarization. Technical report, National Bureau of Economic Research.

Timmer, M., de Vries, G. J., and De Vries, K. (2015). Patterns of structural change in developing countries. In *Routledge handbook of industry and development*, pages 79–97. Routledge.

Van Ark, B. and Jäger, K. (2017). Recent trends in europe's output and productivity growth performance at the sector level, 2002-2015. *International Productivity Monitor*, (33):8–23.

World Bank (2022). World development indicators, wdi [database]. https://databank.worldbank.org/source/world-development-indicators, accessed December 10, 2022.

Online Appendix

A Data Sources

Sectoral aggregation. We obtain sectoral employment and value-added data from the 10-Sector and EU-KLEMS Databases. The 10-Sector Database follows the ISIC Rev. 3.1 classification of economic activity and the EU-KLEMS Database follows ISIC Rev 4. We aggregate sectoral data into services and goods as follows: goods corresponds to ISIC sections A to F (comprising Agriculture, hunting, forestry and fishing; Mining and quarrying; Manufacturing; Electricity, gas and water supply; and Construction), and services corresponds to the remaining sections (sections G to P in ISIC III or sections G to T in ISIC IV).

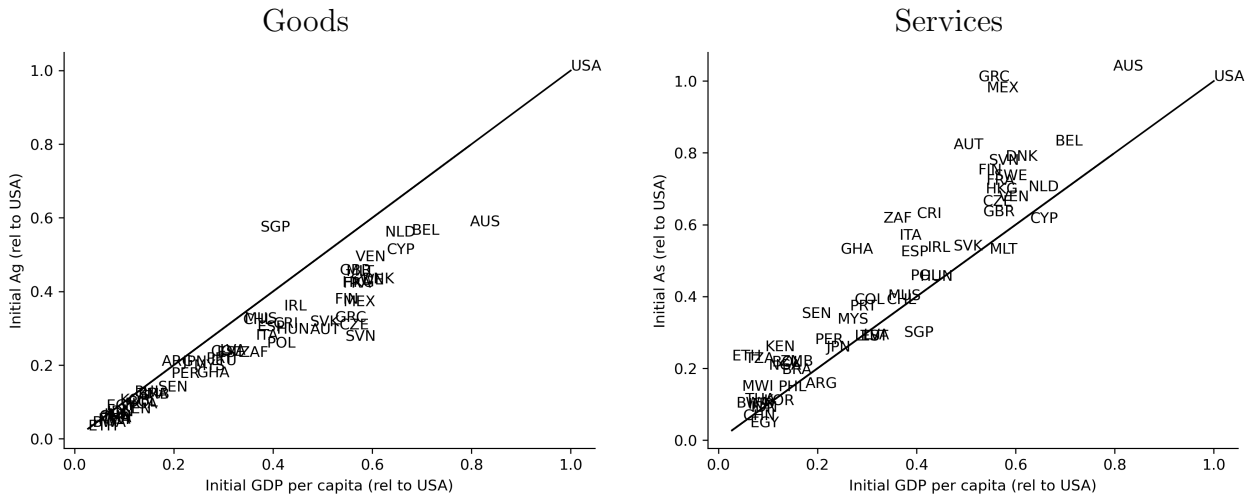
B Other Quantitative Results

Cross-country calibration. Figure B.1 documents the implied level of sectoral productivity across countries calibrated to the initial allocation of employment across sectors and real income per capita differences across countries. As is commonly found in the literature, the implied sectoral productivity differences are larger in goods than in services (Restuccia et al., 2008; Duarte and Restuccia, 2020; Herrendorf et al., 2022).

Elasticity result. To illustrate the implication of the model that an increase in the employment ratio has a substantial effect on the service sector employment disproportionately more than the goods sector, we consider the more standard Generalized Stone-Geary preferences specified as:

$$u(c_g, c_s) = \left(\phi \left(c_g - \bar{g}\right)^{\rho} + (1-\phi) c_s^{\rho}\right)^{\frac{1}{\rho}},$$

Figure B.1: Cross-country initial sectoral productivity



where $\bar{g} > 0$ is a subsistence consumption level of goods, $\phi \in (0, 1)$ is a preference weight, and $\rho < 1$ governs the elasticity of substitution between goods and services.

With this preference specification, the allocation of employment to services can be solved analytically as

$$L_s = \frac{\chi}{1+\chi}\left(L - \frac{\bar{g}}{A_g}\right),$$

where $\chi = \left(\frac{\phi}{1-\phi}\right)^{\frac{1}{\rho-1}} \left(\frac{A_g}{A_s}\right)^{\frac{\rho}{\rho-1}}$.

The magnitude of the sectoral effect of changes in L is given by $\frac{\partial L_s}{\partial L} = \frac{\chi}{1+\chi}$, and depends on the relative weight of goods and services in utility ($\phi/(1-\phi)$), relative sectoral productivity (A_g/A_s), and the parameter ρ. The calibration of our model with this preference specification implies $\rho = -1.5$ and that the term $(\phi/(1-\phi))^{\frac{1}{\rho-1}}$ is about 5; that is employment in services increases by about 0.83 in response to a marginal increase in L (when labor productivity is equal across sectors). In addition, note that, as long as $\rho < 0$, the term $(A_g/A_s)^{\frac{\rho}{\rho-1}}$ grows over time since labor productivity tends to grow faster in the goods sector than the service sector. This additional effect further magnifies, over time, the effect of a given increase in L on service employment relative to goods employment.