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REVISITING THE REAL EXCHANGE RATE MISALIGNMENT-ECONOMIC GROWTH NEXUS VIA THE ACROSS-SECTOR MISALLOCATION CHANNEL

by Claire Giordano*

Abstract

Real effective exchange rate (REER) imbalances may affect economic growth by altering the allocation of labour and capital across sectors. This study assesses whether the component of inter-sectoral production factor misallocation induced by REER misalignments significantly hinders economic development and if this is the only channel via which REER imbalances operate. REER misalignments are derived from a Behavioural Equilibrium Exchange Rate model; labour misallocation and capital misallocation are measured, according to two alternative indicators, on a unique cross-country cross-sector national account dataset of 54 economies and 12 sectors over the years 1980-2015. Both REER over- and undervaluations lead to increased across-sector labour (but not capital) misallocation and, uniquely via this channel, they significantly hamper real growth. The correction of these external imbalances would thus stimulate inter-sectoral allocative efficiency and, ultimately, economic activity.

JEL Classification: F40, F43, O11, O14, O19.
Keywords: external imbalances, real effective exchange rate misalignments, labour misallocation, capital misallocation, economic development.
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1. Introduction[1]

Since the outbreak of the 2008 global financial crisis (GFC), the debate on the causes and consequences of sustained external imbalances has returned to centre stage in both the academic and policy debate. The resurgent literature has focused both on the measurement and detection of these imbalances, as well as on their impact on economic performance. In particular, many studies address whether real effective exchange rate (REER) misalignments matter for economic growth, yet the sign and significance of this nexus are far from settled.

One strand of the literature (e.g. Williamson, 1990; Aguirre and Calderón, 2005; Nouira and Sekkat, 2012; Comunale, 2017) points to systematic REER deviations from "equilibrium" values being bad for growth, regardless of their sign. The channel, which is suggested more or less explicitly in these studies, but never directly tested, is the impact of REER misalignments on the degree of efficiency of the allocation of production factors across sectors, which in turn affects economic development. Persistent real overvaluations may indeed induce distortions in relative prices of traded over nontraded goods that in turn may favour a misallocation of production factors towards the less productive non-tradable sectors, to the detriment of aggregate economic growth (e.g. Razin and Collins, 1999; Edwards, 2000). Moreover, systematic real undervaluations could result in dearer imported goods, they could fuel inflation, curb investment and lead to an expected currency appreciation, which in turn could limit the size of the more productive tradable sectors and hence economic growth (e.g. Jongwanich, 2009; Schröder, 2013).

Another strand of the literature has instead argued that, although overvaluations are bad for development, systematic undervaluations may lead to a rise in the profitability of tradable activities, the flow of production factors to these sectors and, hence, the promotion of economic growth, in particular in the context of weak institutional quality and market failures (Rodrik, 2008).

Although the across-sector production factor misallocation channel has been empirically assessed in the context of actual REER appreciations and depreciations or of

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large shifts in international capital flows (e.g. Reis, 2013; Benigno and Fornaro, 2014; Benigno, Converse and Fornaro, 2015), to our knowledge and with the (partial) exception of Rodrik (2008), it has never been analysed in relation to REER imbalances.

The aim of this paper is hence to empirically gauge whether REER imbalances affect real growth via the inter-sectoral misallocation channel. In order to address this research question, the original contribution to the existing literature is three-fold.

The first two innovations concern measurement issues. First, REER misalignments are more accurately modelled than those generally employed in the REER imbalance-economic growth literature. The most frequent proxy is in fact the difference between actual real exchange rates (RERs) and RERs adjusted by the Balassa-Samuelson effect (as in, for example, Rodrik, 2008 and later works inspired by this study). This paper instead employs a Behaviourial Equilibrium Exchange Rate (BEER) model, thoroughly documented in a companion article (Giordano, 2021), which assesses a set of long-run determinants of RERs of a large panel of medium and high-income countries in order to compute their “equilibrium” values, against which actual exchange rates are appraised. The model, in addition to capturing the Balassa-Samuelson effect, also includes trade costs, terms of trade, government expenditure, the investment rate and demographic factors. In this respect, this paper speaks to the literature on long-run REER determinants (e.g. Lane and Milesi-Ferretti, 2004; Adler and Grisse, 2017; Fidora, Giordano and Schmitz, 2021).

Second, drawing from the most recent productivity literature, we innovatively develop a unique dataset of indicators of across-sector production factor misallocation. The relevant literature on external imbalances and growth has thus far focused simply on the relative size of manufacturing vs. services in terms of labour or value added (Rodrik, 2008; Rajan and Subramanian, 2011; Benigno, Converse and Fornaro, 2015), where manufacturing is taken as a proxy of tradable and services of non-tradable sectors. By building a dataset of value added, labour and capital for the panel of 54 countries underlying the BEER model, across 12 sectors, we more directly measure inter-sectoral labour and capital misallocation for a given country-year over the period 1980-2015. In particular, we construct Ando and Nassar’s (2017) (labour) structural distortion index – given by the gap between sectoral employment share and value added share vectors, in turn a measure of dispersion in sectoral productivities – and Aoki’s (2012) dispersion in labour and capital frictions, measured by the divergence in production factor returns across sectors.[2] Our paper thus also relates to the inter-sectoral production factor allocation and productivity literature, in particular to that stemming from these indicators, such as Dabla-Norris et al. (2015), Di Stefano and Marconi (2016) and Marconi and Upper (2017).

The third innovation concerns the estimation strategy. Instead of only estimating the direct relationship between REER misalignments and economic development based on an "augmented" growth regression setting, as done by the prevalent literature, which captures all possible channels of influence of REER imbalances, this paper employs a two-stage procedure to more narrowly test whether the effect of (either positive or negative) REER misalignments on real growth significantly and uniquely operates via inter-sectoral labour and/or capital misallocation. The attempt to empirically gauge the production factor misallocation channel has, to our knowledge, only been made by Rodrik (2008), the work closest to our paper, yet only by employing rudimentary proxies, as earlier explained, and without assessing the relevance of this channel with respect to others.[3] Indeed, as a complementary approach to our two-stage regressions, via various empirical exercises we also assess whether three other potential channels through which REER imbalances may affect economic development are active for our sample of countries. In particular, albeit with rough proxies given data availability, we focus on: (i) The share of foreign-currency-denominated (FCD) external debt. According to Grekou (2018), a REER undervaluation increases the burden of FCD debt, potentially leading to a decrease in firms' production and weakening the government fiscal position and the banks' balance sheets, hence slowing aggregate growth; a REER overvaluation operates symmetrically. (ii) Export diversification. According to Sekkat (2016), a REER undervaluation (overvaluation) increases (reduces) the cost of importing inputs that are key to the production of sophisticated goods, hence hindering (fostering) export diversification and overall growth; (iii) Within-sector allocative inefficiency across firms. This variable has been found to account for the bulk of current cross-country productivity differences in advanced economies in recent years (e.g. Gamberoni et al., 2016; Calligaris et al., 2017; Garcia-Santana et al. 2020). REER misalignments may indeed affect the

[2] Due to the more limited availability of capital data, we can build capital misallocation measures only for 35 countries, as will later be discussed.

[3] Comparability with the findings of Rodrik (2008) is, however, hindered by the country sample: this paper only focuses on medium- and high-income countries, whereas Rodrik's (2008) study also analyses low-income economies.

allocation of production factors not only across sectors, but also between trading/highly productive and non-trading/weakly productive firms within a given sector.

We find that, for our panel of medium- and high-income countries, REER misalignments (both positive and negative) are significantly related to higher labour (but not capital) misallocation across sectors, which in turn dampens economic growth. In particular, a 10 percentage point REER misalignment of either sign is estimated to shave off around 0.2 percentage points of real GDP per capita annual growth, entirely due to increased inter-sectoral labour misallocation. We can exclude the relevance of the FCD external debt burden, export diversification and within-sector production factor misallocation channels in the REER misalignment-economic growth nexus in our country panel.

The remainder of this paper has the following structure. Section 2 recaps the literature on the link between REER misalignments and economic growth. Section 3 briefly describes the annual BEER model used to derive REER misalignments. Section 4 illustrates two different measures of inter-sectoral allocative inefficiency, as well as the underlying dataset constructed for this purpose. Section 5 describes the regression analysis, gauging the overall relationship between REER misalignments and economic growth specifically via the across-sector misallocation channel. Section 6 concludes.

2. A brief literature review

The extensive literature addressing the linkages between REER misalignments and growth is far from conclusive. One strand (e.g. Williamson, 1990; Aguirre and Calderón, 2005; Nouira and Sekkat, 2012; Comunale, 2017) points a finger at the growth-threatening role of these imbalances, regardless of their sign and size. Indeed, to the extent that REERs are detached from their long-run economic fundamentals, economic performance is hindered owing to the induced distortions in relative prices, thus leading to a sub-optimal allocation of resources across sectors. In particular, overvaluations can block the relocation of surplus labour and capital from low-productivity to high-productivity activities, which are generally found in the tradable sectors (e.g. Razin and Collins, 1999; Edwards, 2000).[4] Undervaluations could instead result in more expensive imported goods, thereby generating domestic inflationary pressures, curbing resources

[4] Overvalued currencies can also be associated with rent-seeking and corruption (e.g. Rodrik, 2008; Christiansen et al., 2009), which in turn are found to exacerbate production factor misallocation (Giordano and Lopez-Garcia, 2018).

available for investment and leading to an expected currency appreciation, which in turn could limit the size of the more productive tradable sectors and, in turn, economic growth (e.g. Jongwanich, 2009; Schröder, 2013).

A second strand of the literature points instead to significant asymmetries at play. In particular, whereas overvaluations are found to lower growth, undervaluations are claimed instead to foster development under certain conditions, in that they contribute to expand the otherwise undersized manufacturing, a sector where long-term productivity prospects are more promising. In particular, Rodrik's (2008) seminal article argues that manufacturing is the channel through which especially emerging economies absorb technological innovation and best practices from abroad; sub-optimally small manufacturing hence lowers aggregate productivity growth. The size of this sector may be constrained for two reasons. First, poor institutions – which reduce the ability of private investors to appropriate their returns on investment, hence blunting the incentives for capital accumulation and technological progress – affect tradables more heavily, in that their production systems tend to be more complex and have a higher share of relationship-specific intermediate inputs. Second, tradable goods often include innovative products, which are more prone to market failures, such as information leakages and credit market imperfections. In both cases, an across-sector misallocation of production factors that penalises manufacturing ensues. REER undervaluation has a positive effect on the relative size of the tradable sector, in turn stimulating economic growth.

Other studies have pointed to a similar channel at play. For example, Glüzmann, Levy-Yeyati and Sturzenegger (2012) find a labour market-enhancing effect of undervaluation reminiscent of classical models of economies with unlimited supply of labour (e.g. Lewis, 1954), due to the shift of workers from unproductive subsistence agricultural jobs into high-productivity industrial jobs. Freund and Pierola (2008) show that undervalued currencies facilitate a reorientation of production towards the most efficient manufacturing industries in low-income economies and therefore an export surge, for which the extensive margin of expansion in new markets and in new products is the main driver. Moreover, a competitive currency could provide stimulus for the development of a non-commodity-dependent tradable sector, therefore avoiding Dutch disease problems (Palma, 2004).

Without focusing on specific channels, the empirical analyses in Collins and Razin (1997), Gala (2008), Di Nino, Eichengreen and Sbracia (2013) and Béreau, López Villavicencio and Mignon (2012) find evidence of a direct, positive effect of undervaluations on economic performance in various countries in their developing phase, in line with Rodrik's (2008) view. However, Couharde and Sallenave (2013) find that too large an undervaluation becomes contractionary, suggesting the presence of non-linearities, in addition to asymmetries, in the REER misalignment-economic growth nexus. Gonçalves and Rodrigues (2017) instead finds no significant direct relationship between REER disequilibria and economic growth, once GDP and REER outliers are removed from the sample and when appropriate control variables (namely, the savings rate) are accounted for.

Finally, two further channels via which REER imbalances may affect real growth have been explicitly suggested by the empirical literature, especially as regards low-income economies. Sekkat (2016) explores whether a REER undervaluation (overvaluation) increases (reduces) the cost of importing inputs (e.g. machinery, intermediate inputs) that are key to the production of sophisticated goods in particular, hence hindering (fostering) export diversification, in turn a driver of economic performance. The study, however, finds no significant correlation between these external imbalances, however signed, and export diversification.

According to Grekou (2018), a REER undervaluation (overvaluation) increases (reduces) the burden of FCD debt, potentially leading to a decrease (rise) in firms' production because of corporate financial distress (improvement) and weakening (strengthening) the government fiscal position and the banks' balance sheets, hence slowing (boosting) aggregate growth. This channel is investigated by estimating the impact of REER imbalances interacted with the FCD external debt share on GDP per capita growth in an "augmented" growth regression framework. The interaction term is found to be statistically significant and is found to offset the effects of REER misalignments on exports (a proxy of the size of the tradable sector), implying that the overall impact of REER imbalances on economic growth is negligible.[5]

Even from this brief overview it is clear that the REER misalignments-growth nexus is still very much open to debate. Importantly, the state of the empirical literature has generally invested more in documenting the REER disequilibria-growth correlation than in identifying channels of influence (Eichengreen, 2008), with the few afore-mentioned exceptions of Rodrik (2008), Sekkat (2016) and Grekou (2018), which

[5] In addition to the impact of the interacted terms on economic growth, Grekou (2018) also estimates the relationship between REER misalignments and the FCD external debt share, finding that REER undervaluations significantly increase the latter in low-income countries.

however do not robustly measure nor econometrically assess the importance of each of the channels considered. For this reason, the remainder of this paper is devoted to a further empirical investigation of the REER misalignment-economic development link, by focusing on the specific channel of across-sector production factor misallocation.[6]

3. Measuring real exchange rate misalignments

In order to measure real exchange rate (RER) misalignments, Rodrik (2008) and subsequent empirical studies (such as Rajan and Subramanian, 2011; Di Nino, Eichengreen and Sbracia, 2013; Gonçalves and Rodrigues, 2017; Habib, Mileva and Stracca, 2017) regress the RER relative to the US dollar of a panel of countries – in turn derived as the ratio of the nominal exchange rate and the purchasing power parity (PPP) conversion rate – against per capita income (capturing the Balassa-Samuelson effect) and time fixed effects, and uses the residual as a measure of misalignment of the local currency.

This measure, however, has several drawbacks. First, it does not take into account additional real factors, other than the Balassa-Samuelson effect, that have been found to drive RERs in the long run (e.g. Adler and Grisse, 2017; Fidora, Giordano and Schmitz, 2021). Second, in Rodrik (2008) the absolute value of GDP per capita is employed to measure the Balassa-Samuelson effect and not the GDP per capita differential relative to the US. Any RER determinant needs indeed to be expressed relative to a numeraire since the RER itself is a bilateral concept, which cannot be determined only by a country's own characteristics, but also reflects "foreign" characteristics (Phillips et al., 2013). Third, as discussed by Woodford (2009), since GDP growth is considered as the only determinant of the RER, and in absolute terms, the positive correlation between undervaluation and economic growth found by Rodrik (2008) could simply be due to the correlation between GDP growth and the GDP growth component underlying the estimated RER misalignments. Finally, the use of bilateral RERs can lead to misleading inference about

[6] As mentioned in the introduction, although the across-sector production factor misallocation channel has been empirically assessed in the context of actual REER appreciations and depreciations or of large shifts in international capital flows (e.g. Reis, 2013; Benigno and Fornaro, 2014; Benigno, Converse and Fornaro, 2015), to our knowledge and with the (partial) exception of Rodrik (2008), it has never been analysed in relation to REER imbalances. The distinction is important in that the mapping between REER appreciations/REER overvaluations and REER depreciations/REER undervaluations is not at all one-to-one. For example, a strong REER appreciation can lead to an overvaluation, all other things equal, if the initial REER is in line with its "equilibrium" value, consistent with underlying economic fundamentals; conversely, it could lead to a narrowing down of a significant REER undervaluation, bringing the actual REER close to its "equilibrium" value. Moreover, a significant REER misalignment could emerge even in the absence of REER fluctuations, due to changes in the REER "equilibrium" path linked to strong movements in economic fundamentals (*vis-à-vis* a given country's set of trading partners).

overall external imbalances, which are captured by the REER, not the RER, and which ultimately determine aggregate macroeconomic outcomes.

To overcome all these issues we hence employ a Behavioural Equilibrium Exchange Rate (BEER) model, which estimates the long-run reduced-form relationship between RERs, on the one hand, and key macroeconomic fundamentals, on the other hand (Clark and MacDonald, 1998) and from which RER and REER misalignments may be derived.[7] A similar approach when analysing the REER misalignment-economic growth nexus has been adopted in Aguirre and Calderón (2005), Berg and Miao (2010), Nouira and Sekkat (2012), Schröder (2013), Comunale (2017) and Grekou (2018), yet these studies do not then measure and explore the production factor misallocation channel, object of this paper. Details of the construction of the BEER model are found in Giordano (2021); hereon and in Annex A we only describe the general methodology.

The BEER model is estimated over the period 1980-2017 for 55 countries, listed in Table A1, accounting for over 90 per cent of global GDP. The sample covers emerging and advanced economies, yet excludes low-income economies for lack of sufficiently long and qualitatively reliable time series. The variables employed in the model, and the sources from which they are retrieved, are summarised in Table A2.

The dependent variable is the bilateral RER (rer_t) of each currency *vis-à-vis* the US dollar (the numeraire currency), defined in such way that an increase corresponds to a real appreciation of the domestic currency *vis-à-vis* the numeraire. Yearly average

[7] The BEER methodology is labelled this way due to the fact that it is based on the assumption that the "behaviour" of a REER is determined by the "behaviour" of its macroeconomic drivers in the long run. It hence exploits empirical regularities to derive equilibrium REERs without imposing any external restriction and is a positive approach, since it is not based on any normative assumption. Amongst the main alternative models in the real exchange rate literature, the Natural Real Exchange Rate (NATREX) methodology, originally formulated by Stein (1990), is instead theoretically grounded, on a dynamic stock-flow model. In particular, it defines the "natural" REER as the REER that ensures both the internal and the external equilibrium simultaneously in the long run. However, although there have been some attempts to measure the structural model underlying the NATREX (e.g. Gandolfo and Felettigh, 1998; Siregar and Rajan, 2006), this approach often boils down to estimating a reduced-form equation, undermining its theoretical stance. The Fundamental Equilibrium Exchange Rate (FEER) methodology, advocated by Wren-Lewis (1992), is also generally based on a partial equilibrium model and, in particular, on the computation of the REER adjustment required to close the gap between the cyclically adjusted current account and the "current account norm", which represents an optimal value of the current account over a medium-term horizon. The calibration of the required REER adjustment is, however, highly sensitive to the assumptions made concerning both exchange-rate pass-through coefficients and price elasticities of trade (Schnatz, 2011). Although no model is superior to the others (Giordano, 2021), BEER models are generally employed given their empirical simplicity and lack of underlying theoretical or normative assumptions.

nominal exchange rates are deflated by the PPP rate, in line with the existing REER misalignment - economic growth literature.[8]

The explanatory variables of the model are justified by economic theory and selected via Bayesian model averaging techniques. In particular, the BEER model is specified as follows:

$$(1) \quad rer_{i,t} = \beta_{1i} gdppc_{i,t} + \beta_{2i} trade_{i,t} + \beta_{3i} tot_{i,t} + \beta_{4i} gov_{i,t} + $$
$$+ \beta_{5i} inv_{i,t} + \beta_{6i} oad_{i,t} + FE_i + \varepsilon_{i,t},$$

where *i* indicates the country, *t* the year, $gdppc_{i,t}$ is GDP per capita (a proxy of the Balassa-Samuelson effect), $trade_{i,t}$ measures trade costs, $tot_{i,t}$ captures the terms of trade, $gov_{i,t}$ measures government consumption, $inv_{i,t}$ is the investment rate, $oad_{i,t}$ measures the old-age dependency ratio, FE_i are fixed effects, namely country fixed effects and cross-section means of both the dependent and explanatory variables (the latter issue is discussed further on), and $\varepsilon_{i,t}$ is a random error. All the regressors are expressed relative to the corresponding variable for the United States, as is the dependent variable.

Given the properties of the panel data, the chosen estimation method is the common correlated effects mean group estimator developed by Pesaran (2006) and Kapetanios, Pesaran and Yamagata (2011), which has the advantage, in a cointegration setting, both of exploiting country heterogeneity in the estimation of the coefficients and of tackling cross-sectional dependence, by augmenting country-specific equations with the cross-section averages of the dependent and independent variables, in turn observable proxies for the (unobserved) common shocks to the panel. Coefficients are estimated country-by-country and then averaged across countries;[9] estimation results are reported in Table A3.

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[8] At the time of writing of this paper, the 2017 International Comparison Program benchmark for the PPP rate was not yet available; hence the previous ICP vintage and resulting IMF-WEO series are employed herein. These older data are consistent with the national account vintages employed in Section 4.2. Alternative price indices with which RERs are commonly constructed include the consumer price index (CPI), the GDP deflator and the producer price index (PPI). In Annex E we report a robustness check conducted on alternatively deflated REER misalignments.

[9] Using a unique panel equation for calculating equilibrium exchange rates relies on the very strong assumption that the same behaviour of economic fundamentals applies to all countries, which often include both advanced and emerging economies, as in this paper. To some extent, this is a desirable property: the economic fundamentals that drive RERs in the long term should be the same across countries, especially since, looking forward, emerging economies should behave more like advanced economies. In other terms, estimating a single equilibrium exchange rate equation for all countries allows smoothing the impact of individual countries' transitional dynamics (Bénassy-Quéré, Lahrèche-Révil and Mignon, 2008; 2011). However, the exact relation between the dependent variable and each of its drivers may differ across countries. Allowing for country heterogeneity – as opposed to imposing a homogeneity condition across

The equilibrium RER values for each country are obtained as fitted values based on these average coefficients and on Hodrick-Prescott filtered explanatory variables. The equilibrium REERs are then computed by weighting the equilibrium RERs with three-year time-varying trade weights sourced from the ECB (generally, *vis-à-vis* 54 countries; again see Table A2 for details). The percentage-point difference between the actual and the "equilibrium" REER is labelled as the REER misalignment, as follows:

$$(2)\ mis_{i,t} = \left(reer_{i,t} - reer_{i,t}{}^{*} \right) * 100$$

where the asterisk denotes the equilibrium value. Given how the REER is defined, when the misalignment is negative (positive), and therefore the actual REER is more depreciated (appreciated) than the equilibrium REER, it implies an undervaluation (overvaluation) of the actual REER.

Table 1 provides some summary statistics of the estimated REER misalignments. On average since 1980 REERs have been undervalued in the range of 8 per cent; undervaluations have been more frequent than overvaluations. However, there is large variation across countries, with an average standard deviation of 28 per cent. Advanced economies' REERs were on average broadly aligned with economic fundamentals, and overvaluations were slightly more frequent for these countries than undervaluations. Conversely, emerging economies' REERs were on average undervalued by 22 per cent, and undervaluation episodes largely outnumbered overvaluations. Figure A1 in Annex A depicts REER misalignments over 1980-2015 of selected countries (the four main euro-area countries, China, India and the United States).

Table 1. Descriptive statistics of PPP-deflated REER misalignments

(percentage points for mean, min and max statistics)

	Mean	St. dev.	Min		Max		N. obs	N. positive	N. negative
All countries	-8.4	27.6	-289.7	(BG 1991)	173.6	(AR 1986)	1950	833	1117
Advanced economies	-0.6	17.7	-128.3	(LV 1992)	48.3	(JP 1995)	1250	659	591
Emerging economies	-22.1	35.7	-289.7	(BG 1991)	173.6	(AR 1986)	700	174	526

Source: author's estimates based on the BEER model in Giordano (2021).

all countries in the panel (which has been rejected in Giordano, 2021, to which we refer) as in a standard fixed-effect regressions – is hence key to achieving consistent estimates. In the following step of computation of long-run, slow-moving equilibrium real exchange rates, in the mean-group procedure a common coefficient is employed, yet reflecting the underlying heterogeneity in the panel, as is quite standard in the BEER model literature (e.g. Hlouskova and Osbat, 2009; Bussière et al., 2010; Hossfeld, 2010; Fidora et al. 2021); in this manner, the country-specific component of the equilibrium rate stems solely from the (cyclically-adjusted) shifts in each county's economic fundamentals.

4. Measuring the inter-sectoral misallocation of production factors

4.1 An overview

In this section we construct two alternative synthetic indicators of the degree of allocative inefficiency across sectors. The first measure, namely the indicator of structural distortions put forward by Ando and Nassar (2017), focuses only on labour as a production input. The second proxy, Aoki's (2012) measure of frictions, instead considers both labour and capital. Both indices capture the extent of misallocation without identifying the underlying distortion driving it and are hence classifiable as "indirect" misallocation indicators (Restuccia and Rogerson, 2017); they essentially assume a production structure and then use the data to estimate wedges in the first-order conditions that characterize an efficient allocation. The wedges are then interpreted as reflecting distortions to efficient allocations.[10]

The inter-sectoral misallocation dataset constructed herein is unique due to the large number of countries included (54, the 55 countries of the BEER model depicted in Section 3, bar Algeria for data availability issues), the wide time coverage (1980-2015), the sectoral dimension (12 1-digit sectors), as well as the exhaustiveness in terms of the number of possible proxies of inter-sectoral allocative inefficiency.

The two employed measures display at least two strengths relative to alternative indicators adopted in the external imbalance-growth literature. First, they do not refer solely to labour or valued added (VA) in manufacturing and in services, in turn employed as very rough proxies of tradable and non-tradable sectors (e.g. Rodrik, 2008; Benigno, Converse and Fornaro, 2015). Rather, they exploit information on all relevant 1-digit sectors. Second, the two indicators measure the *level* of across-sector allocative inefficiency in an economy, and not the *change*, which is the only component directly captured by productivity decompositions.[11] In our analysis we are indeed interested in investigating the link between the level of REER misalignments and the level of input misallocation (and ultimately its impact on economic growth).

[10] Unlike the "direct approach", the indirect one does not require specifying a full model nor conducting quasi-natural experiments that shed light on a particular source of misallocation. Although measurement issues are clearly documented in the literature, the advantage of employing panel data as in this paper, which the direct approach cannot use, is that of being able to capture levels and changes in misallocation in different countries and periods.

[11] Shift-share decompositions – which break down aggregate productivity growth into productivity changes within sectors and labour reallocation across sectors – are provided in McMillan and Rodrik (2011), de Vries, Timmer and de Vries (2015), and Giordano and Zollino (2021), amongst many other studies. The productivity growth decomposition in Borio et al. (2015) is also similar in spirit.

Albeit unique in coverage, our dataset presents several drawbacks, common both to the underlying cross-country cross-sector databases and to the employed misallocation measures. Indeed, from an empirical perspective, it is not possible to construct more refined measures of labour (e.g. corrected for hours worked, human capital, etc.) or of capital (e.g. breaking down the heterogeneous asset types).[12] Moreover, despite the more granular level than the existing literature, analysing 1-digit sectors necessarily masks the underlying heterogeneity of production factors, output and productivity across more disaggregated sectors (or even across firms).

From a theoretical standpoint, the modelling frameworks of this paper are based on maximum two production factors, thus ignoring intermediate inputs, land, energy, etc.[13] Moreover, the misallocation measures disregard the possibility that occupational choices are based on factors other than wages, such as geographic mobility costs and amenities, and in general are based on restrictive production factor assumptions (e.g. a Cobb-Douglas production function). Finally, the employed misallocation measures may overstate the extent of actual production factor allocative inefficiency, as they may also capture adjustment costs, experimentation by firms with new technologies, variable mark-ups etc. (as discussed, for example, in Gamberoni, Giordano and Lopez-Garcia, 2016; Bańbura et al., 2018).

4.2 The dataset

Our raw data (national accounts by economic sector of activity at both current and constant prices) are sourced from several vintages of KLEMS initiatives (EU KLEMS, World KLEMS, LA KLEMS, Asia KLEMS, India KLEMS, China Industrial Productivity Database),[14] the GGDC 10-Sector and the OECD Structural Analysis (STAN) Databases.[15] For VA and employment, and the resulting labour misallocation measures,

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[12] To our knowledge, only Dabla-Norris et al. (2015) and Samuels (2017) have made a skill adjustment, but their country panels only refer to a dozen countries for which the necessary data are available. Samuels (2017) also takes capital asset heterogeneity into account.

[13] Jones (2011) and Wu and Zhang (2016) employ a gross output, as opposed to VA, approach, hence including intermediate inputs; these studies, however, are taken to the data only for few countries.

[14] Available at http://www.worldklems.net/data.htm and follow-up links. At the time of writing of this paper the EU KLEMS 2019 release was not available, hence we employed the previous 2018 vintage. This choice is, however, consistent with the other KLEMS datasets, which have not instead been updated, and with the PPP measures underlying the BEER model described in Section 3. Details on the construction of variables country by country are provided in Annex B.

[15] These databases are available, respectively at https://www.rug.nl/ggdc/productivity/10-sector and at https://stats.oecd.org/Index.aspx?DataSetCode=STANI4_2016 . At the time of writing of this paper, the OECD STAN Database was the only dataset updated until 2016. However, as it only covers OECD countries, we preferred to consider the same time span (i.e. until 2015) for all countries.

we are able to construct sectoral series for 54 countries. Physical capital stock and capital compensation data are instead constructed for a subset of 35 countries, flagged in Table A1. Series are generally built from 1980 to 2015 (the time span is sometimes shorter especially for capital input data).

Sectors are reclassified at a 1-digit level, in accordance with the ISIC Rev.4/NACE Rev.2 industry coding, and twelve, listed in Table 2, are employed in this paper.[16] Figure D1 in Annex D reports sectoral real productivity levels, confirming large sectoral heterogeneity. The sectors can be grouped into "tradable" and "non-tradable" sectors, for example following Manu and Castillo's (2015) classification, which defines a sector as tradable if the average export to VA ratio is greater than 10 per cent.[17]

Table 2. The sectoral classification

Code	Sector	Tradability
A	Agriculture, forestry and fishing	YES
B	Mining and quarrying	YES
C	Manufacturing	YES
D-E	Electricity, gas and water supply	NO
F	Construction	NO
G	Wholesale and retail trade; repair of motor vehicles and motor cycles	NO
H	Transportation and storage	YES
I	Accommodation and food storage activities	NO
J	Information and communication	NO
K	Financial and insurance activities	YES
M-N	Professional, scientific, technical, administrative and support service activities	NO
R-S	Arts, entertainment, recreation and other service activities	NO

Notes: The tradability of a sector is based on Manu and Castillo's (2015) classification.

[16] The excluded sectors are those generally dropped from productivity analyses (e.g. Giordano and Zollino, 2021), that is: real estate activities (L), due to the fact that the VA of this sector is mostly made up of imputed rents of owner-occupied dwellings which do not have an employment counterpart; public administration, defence and compulsory social security (O), whose VA is based on public employees' wages and for which computing productivity in a standard fashion is hence not meaningful; health (P) and education (Q), which, to a different degree across countries, are partially public and thus fall under the previous category; activities of households as employers, undifferentiated goods- and services-producing activities of households for own use (T) and activities of extraterritorial organizations and bodies (U), for their residual importance.

[17] The results of this paper based on the tradable/non-tradable classification are also robust to the inclusion of sector J "Information and communication" amongst the tradable sectors, as in Mian and Sufi (2014) and Piton (2018). In particular, Mian and Sufi (2014) defines a sector as tradable if total trade per worker represents more than $10,000; Piton (2018) if total exports represent more than 10 per cent of the sector's total production. In all mentioned classifications, tradability of a sector is not country-specific and does not change over time.

4.3 Ando and Nassar's (2017) structural distortion index

4.3.1 The measure

Ando and Nassar (2017) develops a general equilibrium model, formalised in Annex C1, whose equilibrium conditions lead to an indicator of structural distortion (SDI) – in turn a measure of inter-sectoral labour misallocation – defined as the Euclidian distance between sectoral VA and employment share vectors:

$$(3)\ SDI = d = \sqrt{\sum_i d_i^2},$$

where $d_i = \frac{L_i}{\sum_k L_k} - \frac{VA_i}{\sum_k VA_k}$ and i denotes one of k economic sectors of activity.[18] If the distance $d = 0$, this condition is equivalent to sectoral labour productivity equalization, i.e. the equilibrium scenario:

$$(4)\ \frac{L_i}{\sum_k L_k} = \frac{VA_i}{\sum_k VA_k}\ \forall i \Leftrightarrow P_i = \frac{VA_i}{L_i} = P = \frac{\sum_k VA_k}{\sum_k L_k}\ \forall i.$$

In the presence of free labour mobility, workers should find it convenient to move to the high-productivity sectors, thereby leading to productivity convergence across sectors ($d = 0$). However, if a dispersion in sectoral labour productivities persists ($d \neq 0$), this signals the presence of impediments ("structural distortions") to an efficient reallocation of labour. The larger the distance d, the higher the labour misallocation in the overall economy. Accordingly, d_i represents the level of distortion of sector i: in particular, if $d_i > 0$ (< 0) the sector employs too many (few) workers.

The advantage of using d and d_i as aggregate and sector-specific indicators of distortions, as opposed to the inter-sectoral dispersion in labour productivity, is, first, that they easily allow country and time comparisons in that they are free of the unit of measurement of VA. Second, they take into account the importance in size of each sector. Indeed, d_i can be rewritten as the percentage deviation of sectoral productivity from aggregate productivity weighted by the employment size of the sector:

$$(5)\ d_i = -\frac{L_i}{\sum_k L_k}\left(\frac{P_i - P}{P}\right).$$

Due to structural change, often the sectors with the highest productivity are the smallest, therefore a high d_i is more informative than a high sectoral productivity P_i. An immediate corollary is that sectoral distortion does not necessarily preserve the order of sectoral productivity. Indeed:

[18] The model underlying Ando and Nassar's (2017) measure would lead to equation 3 being computed in nominal terms. We hence consider nominal VA shares as our baseline proxy and provide results based on the corresponding real shares as a robustness check (Table D1 and Figure D1 in Annex D).

$$(6)\ P_i - P_j = -\frac{\sum_k VA_k}{L_i}\{d_i - d_j + \left(1 - \frac{L_i}{L_j}\right) d_j\}.$$

Hence, even if $d_i = d_j$, the order of the sectoral productivities can vary depending on the size of the two sectors.

Finally, amongst their algebraic properties, these indicators are bounded from both sides: $-1 \le d_i \le 1$ and $0 \le d \le \sqrt{N}$ (where N is the number of sectors) and the sectoral distortions add up to zero: $\sum_i d_i = 0$. This last property implies that d is the standard deviation of $\{d_i\}$ with uniform probability over all sectors. In other terms, the presence of a distorted sector necessarily implies the existence of another sector that is distorted in the opposite direction.

4.3.2 Our estimates of total-economy and sectoral structural distortion

Table 3 depicts both the average level of the SDI by country and sub-period, as well as the country ranking, for a relevant subset of economies. In the upper range of the table, France and Italy feature amongst the most efficient economies from a labour perspective, together with the United States until 1992, Spain in the period 1993-2007 (due to low levels of labour misallocation in the Nineties) and Germany thereafter. In the lower range, emerging economies display a large degree of labour misallocation.[19]

Table 3. The total-economy SDI in selected countries: levels and ranking

	1980-1992		1993-2007		2008-2015	
Country:	SDI	*Country ranking*	SDI	*Country ranking*	SDI	*Country ranking*
France	0.08	1	0.07	2	0.08	1
United States	0.08	2	0.10	4	0.12	4
Italy	0.08	3	0.07	1	0.08	2
Germany	0.09	4	0.10	5	0.11	3
Netherlands	0.12	5	0.12	7	0.14	7
Spain	0.13	6	0.09	3	0.12	5
United Kingdom	0.13	7	0.11	6	0.12	6
China	0.31	8	0.38	9	0.32	9
India	0.38	9	0.39	10	0.35	10
Brasil	-	-	0.29	8	0.19	8

Source: author's estimates.

Notes: The total-economy SDI is based on nominal VA shares. Averages may be taken on shorter sub-periods than those displayed herein for some countries, according to the data availability reported in Table C1 in Annex C. Figures highlighted in green (red) refer to the three most (least) "efficient" countries amongst the ten countries listed. A rise in the SDI entails a rise in labour misallocation.

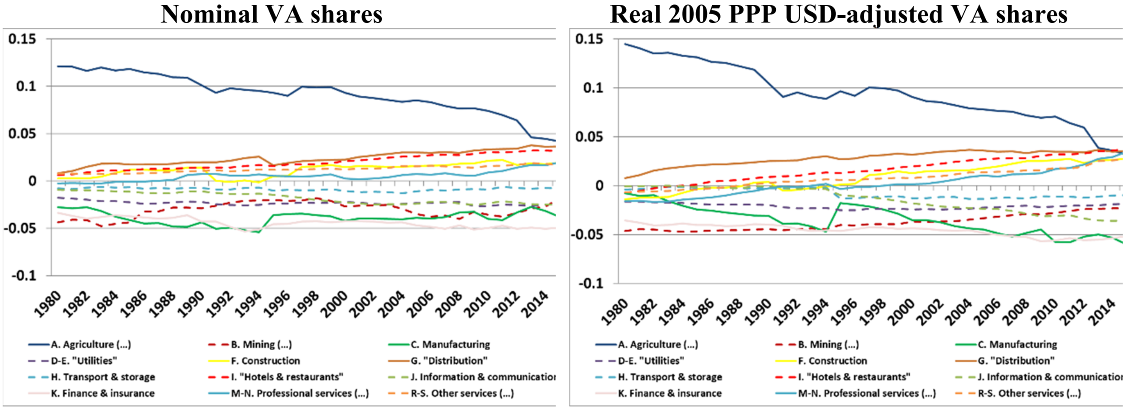
[19] See also Table D2 based on an even larger sample of countries, which confirms this finding). Furthermore, Figure D1 in Annex D focuses on annual SDI dynamics in selected countries.

Ando and Nassar's (2017) framework also allows pinning down the industry origin of total-economy inefficiency (Fig. 1). Negative (positive) values of the index imply under-employment (over-employment) in a given sector. Agriculture started off in 1980 as the largest contributor to overall misallocation, due to its excessive labour, and is still so, albeit to a lesser extent. Manufacturing has displayed large under-employment and in 2015 it stood out as the sector with the greatest labour distortion of negative sign, together with financial activities. Finally, construction, distribution, food and accommodation, professional and "other" services recorded a rise in their SDI over time, currently marking high levels of excess labour.[20]

Figure 1. Sectoral SDIs

(averages across all countries)

Nominal VA shares | **Real 2005 PPP USD-adjusted VA shares**



Source: author's estimates.

Notes: Negative (positive) values of the SDIs imply under-employment (over-employment) in a given sector; misallocation is null when the indicator is zero. A rise in labour misallocation is signalled either by a decrease of a negative value or by an increase of a positive value.

4.4 Aoki's (2012) measure of sector-level frictions

4.4.1 The measure

An alternative measure of misallocation, which refers to both labour and capital, is derived from Aoki (2012). In an environment without any frictions the optimal allocation of factor inputs across sectors requires the equalization of marginal revenue; deviations from this perfect competition outcome represent a misallocation of resources. As in Chari, Kehoe and McGrattan (2002), in a static general equilibrium model frictions (e.g. product and labour market regulation, financing constraints, corruption etc.) can be modelled as linear taxes on sectoral capital and labour, such that capital and labour costs are $(1+\tau_{K,i})p_k$ and $(1+\tau_{L,i})p_l$, respectively.

[20] These findings tally well with the information on labour productivity levels illustrated in Figure B1 in Annex B. Figure D3 in Annex D zooms into the sectoral SDIs of the seven countries reported in Figure 1.

The details of Aoki's (2012) model are described in Annex C2. In a nutshell, by combining the first order condition of a profit maximization problem of a firm adopting a Cobb-Douglas technology with two production factors, it is possible to derive and operatively back out from national account data a measure of sectoral capital and labour frictions:

(7) $\lambda_{K,i} = (\frac{\sigma_i \alpha_i}{\alpha})^{-1} \frac{K_i}{K}$ and

(8) $\lambda_{L,i} = (\frac{\sigma_i (1-\alpha_i)}{(1-\alpha)})^{-1} \frac{L_i}{L}$.

where σ_i is the nominal sectoral VA share ($\sigma_i \equiv \frac{p_i Y_i}{Y}$) and α is the VA-weighted average of capital income shares ($\alpha \equiv \sum_i \sigma_i \alpha_i$). Industry-specific frictions are hence measured by the difference in production factor returns across sectors (in particular by the ratio of the reciprocal of sector i's return on a given production factor and the mean of the reciprocals of the same production factor returns across sectors). Thereby, the more the sectoral return on capital or labour diverges from the mean of the other sectors of a given economy, the higher the measured frictions.

It is noteworthy that the absolute magnitude of the taxes on capital and labour $\tau_{K,i}$ and $\tau_{L,i}$ does not affect across-sector resource allocation. Indeed, as explained in Annex D2, if the taxes on capital (labour) were the same across sectors, then $\lambda_{K,i}$ ($\lambda_{L,i}$) becomes unity, similarly to the case of a frictionless economy. In this setting total output can be increased only by boosting the overall quantity of labour or capital and not via a reallocation of production factors across sectors. If instead $\tau_{K,i}$ is lower than $\tau_{K,j}$, for example, then $\lambda_{K,i}$>1 and $\lambda_{K,j}$<1. Since capital is relatively less expensive in sector *i* (because it is "taxed" less than in the rest of the economy), then it shifts to this sector, leaving at least one other sector in the economy with insufficient capital. As in the case of the SDI, a departure from the mean in one sector induces a misallocation of the production factors in all other sectors. Therefore, from an empirical standpoint the distribution of distortions across sectors can be considered as a proxy of total-economy inter-sectoral production factor misallocation: the wider the distribution, the further away the economy is from a frictionless benchmark and the higher is total-economy misallocation.

In order to operationalise the measures in equations 7 and 8, sectoral capital stock is constructed in real PPP-adjusted terms, as in Aoki (2012; again see Annex B for details).[21] For the capital income shares α_i we use capital compensation as a share of total nominal VA. In particular, given the low quality of these data for some sectors in emerging economies (e.g. Marconi and Upper, 2017), we use country-specific capital income shares for the advanced countries in our sample, whereas for emerging economies we adopt the average capital compensation shares across the former advanced countries.[22] We find that capital income shares vary significantly across sectors, yet not over time (Fig. B2 in Annex B), confirming the soundness of adopting time-invariant measures.

As in Di Stefano and Marconi (2016), in order to capture the total-economy dispersion in labour and capital frictions respectively, we compute the (weighted) Gini coefficient of the sector-level measures $\lambda_{L,i}$ and $\lambda_{K,i}$ for each country in all sample years. The weights are the sector shares in nominal VA: the more the wedge in a sector diverges from the average level and the higher the sector's VA share, the more it contributes to the overall dispersion. Relative to standard deviations, employed for instance in Hsieh and Klenow (2009), the Gini coefficient has the additional advantage of being scale-independent since it varies between 0 – which implies sector equalization – and 1, the highest level of dispersion, thereby resulting comparable both across countries (similarly to the SDI) and across production factors.

4.4.2 Our estimates of total-economy and sectoral labour and capital frictions

The first takeaway is that within each country inter-sectoral capital misallocation is generally higher than labour misallocation (Table 4), possibly due to lower inter-sectoral capital mobility and/or to a higher degree of irreversibility of investment in physical capital.[23] Second, countries can be ranked quite differently according to the type of misallocation. For example, Italy's labour misallocation is confirmed to be very limited, yet its capital stock appears to be significantly misallocated across sectors, especially since 1993. Third, the three reported emerging economies are again classified

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[21] Results (available upon request) are also confirmed when the nominal capital is used, as in Di Stefano and Marconi (2016).

[22] We hence differ from Aoki (2012) and its applications (e.g. Di Stefano and Marconi, 2016; Marconi and Upper, 2017), which adopt the capital income share of the US for all countries, arguing that the US shares do not suffer from significant measurement issues. We indeed claim that the shares of all advanced economies, based on official national account data, have no reason to suffer more from measurement bias than those of the US and hence prefer to use country-specific shares as much as possible in order to map actual country-specific trends. Table B2 compares the sector-specific 1980-2015 average capital income shares for the set of advanced economies with those of the US.

[23] The higher misallocation of capital with respect to labour is a common finding also within sectors (e.g. Lanteri, Medina and Tan, 2020).

very poorly in terms of labour allocation, but capital misallocation appears to be high only in India. Indeed, as also found in Marconi and Upper (2017), capital misallocation is more relevant for advanced countries, whereas labour misallocation is for emerging economies, also reflecting the much lower capital-to-labour ratios in the latter.[24] In general, the Aoki (2012) measure of total-economy labour misallocation and the aggregate SDI are found to be significantly correlated, both in levels and annual growth rates, especially in the case of emerging economies (Table D3 in Annex D).

Table 4. Total-economy dispersion in production factor frictions: levels and ranking

(Gini coefficient, weighted with nominal VA shares)

A. Labour

	1980-1992		1993-2007		2008-2015	
Country:	Dispersion in labour frictions	*Country ranking*	Dispersion in labour frictions	*Country ranking*	Dispersion in labour frictions	*Country ranking*
France	0.14	3	0.11	2	0.11	1
United States	0.15	5	0.17	6	0.20	6
Italy	0.14	2	0.11	1	0.13	2
United Kingdom	0.19	6	0.19	7	0.21	7
Germany	0.11	1	0.13	3	0.18	5
Netherlands	0.14	4	0.14	4	0.18	4
Spain	0.22	7	0.16	5	0.17	3
China	0.33	8	0.44	9	0.40	9
India	0.40	9	0.44	10	0.43	10
Brasil	-	-	0.42	8	0.32	8

B. Capital

	1980-1992		1993-2007		2008-2015	
Country:	Dispersion in capital frictions	*Country ranking*	Dispersion in capital frictions	*Country ranking*	Dispersion in capital frictions	*Country ranking*
France	0.34	4	0.38	6	0.29	5
United States	0.45	8	0.34	4	0.27	2
Italy	0.40	5	0.49	9	0.49	9
United Kingdom	0.41	6	0.40	8	0.43	8
Germany (1)	0.22	1	0.34	3	0.40	6
Netherlands	0.30	2	0.27	1	0.29	4
Spain	0.44	7	0.29	2	0.27	3
China	0.32	3	0.39	7	0.42	7
India	0.53	9	0.54	10	0.54	10
Brasil	-	-	0.34	5	0.26	1

Source: author's estimates.

Notes: Total-economy labour (capital) misallocation is computed as the weighted Gini index of sector-level labour (capital) frictions, where the weights are nominal VA shares and average capital income shares.. Figures highlighted in green (red) refer to the three most (least) "efficient" countries amongst the ten countries listed. An increase in the dispersion in capital (labour) frictions across sectors entails a rise in total-economy capital (labour) misallocation. (1) Capital stock data for Germany are only available since 1991, hence the first sub-period for this country only covers 1991 and 1992.

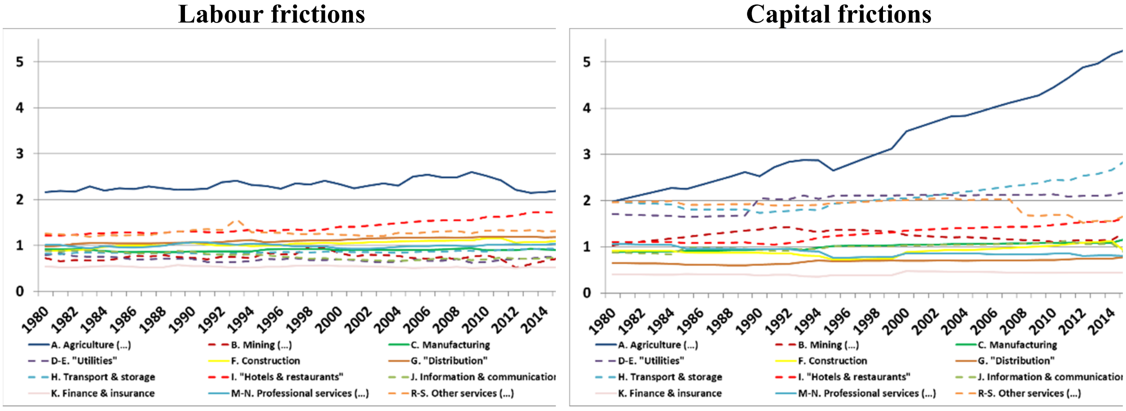
Moving to sectors, we once again find the strongest misallocation in agriculture, linked to excessive labour and, especially, capital (Fig. 2); in the latter case misallocation has actually increased over time. Labour misallocation is also due to (increasing) overemployment in restaurants and accommodation and other personal services, and to

[24] Figure D4 in Annex D depicts labour and capital misallocation in a subset of countries.

systematic underemployment in finance and insurance, confirming SDI developments. Capital misallocation, on the other hand, reflects an excessive allocation of capital to both transport and storage and utilities and under-capitalization of finance and insurance, distribution and professional services. Both the labour and capital results are very similar to those in Aoki (2012) and in Dabla-Norris et al. (2015).

Figure 2. Sectoral production factor frictions
(averages across all countries)

Labour frictions **Capital frictions**



Source: author's estimates.
Notes: Values greater (smaller) than unity imply excessive (too little) labour or capital in that sector. A rise in misallocation is signalled by a higher deviation from unity.

5. REER misalignments, inter-sectoral production factor misallocation and economic growth: regression analysis

After having constructed both a dataset of REER misalignments and of inter-sectoral production factor misallocation for the same set of country-years, in this section we address our research question on whether REER imbalances affect real growth via the inter-sectoral misallocation channel.

5.1 REER misalignments and economic growth

5.1.1 The baseline specification

In the first step of our regression analysis we assess the reduced-form relationship between REER misalignments and real growth, as done in the prevalent literature, which captures all the channels via which the former may affect the latter. In particular, we estimate an augmented growth regression, in which average annual real GDP per capita growth over five-year periods, expressed in PPP terms and based on IMF WEO data, is regressed against the five-year average REER misalignment, initial GDP per capita and the five-year average savings rate, as in the following equation:

(9) $\overline{\Delta gdppc}_{i,t} = \beta_1 gdppc_{i,t_0} + \beta_2 \overline{reermis}_{i,t} + \beta_3 \overline{savrate}_{i,t} + f_i + f_t + \varepsilon_{i,t}$,

where i is one of 54 countries, t is one of seven five-year periods covering the period 1980-2015, t_0 is the initial year of each five-year period, upper bars represent five-year averages and $\varepsilon_{i,t}$ is the regression error. Non-overlapping five-year periods are taken, as is standard in the growth literature, in order to smooth out short-term disturbances (e.g. Islam, 1995).[25] This "contemporaneous" (i.e. within five-year periods) relationship between the dependent and explanatory variables (with the exception of GDP per capita, appraised at the beginning of each period) is similarly investigated, for example, by Rodrik (2008), Schröder (2013) and Gonçalves and Rodrigues (2017).

The variable of interest, the REER misalignment ($\overline{reermis}_{i,t}$), is estimated as described in Section 3; it is first considered in absolute terms, and then split into positive and negative deviations, in order to capture any asymmetric effect (found, for example, in Razin and Collins, 1999 and Aguirre and Calderón, 2005). When the misalignment is expressed in absolute terms, then a statistically significant negative $\hat{\beta}_2$ implies that REER deviations from their "equilibrium" hinder economic growth; the same interpretation is given when REER overvaluations are considered in equation 9. Conversely, if REER undervaluations are included in the regression, then a statistically significant positive $\hat{\beta}_2$ signals a negative correlation between REER misalignments and growth.

As growth control variables, we include initial GDP per capita ($gdppc_{(i,t_0)}$), consistently with the standard conditional convergence hypothesis (Barro and Sala-i-Martin, 2004), and gross domestic savings (as a percentage of GDP, sourced from IMF WEO; $\overline{savrate}_{i,t}$). As well as being a relevant driver in standard growth models, the inclusion of the latter variable is consistent with the uphill capital flow literature based on the prominent study by Prasad, Rajan and Subramanian (2007), which points to current account surpluses (in turn the result of higher domestic savings than domestic investment) fostering economic performance. Indeed, when facing improved domestic investment opportunities and associated higher incomes, emerging economies with underdeveloped financial systems cannot use arm's-length foreign capital to ramp investment up substantially and accelerate growth. Given the presence of both advanced and emerging

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[25] This is a rough, albeit standard, procedure of purging cyclical movements. Business cycles may indeed differ across countries, yet there is evidence of large real output synchronization between, for example, advanced and emerging economies over the five-year horizon (Agénor, McDermott and Prasad, 1999). In principle the five-year averaging may be problematic for the REER misalignment variable, in that if misalignments switch sign within the given time span, their five-year mean may be close to zero, when in each of the five years misalignments may actually have been sizeable, yet simply oppositely signed (Schröder, 2013). Our analysis is not affected by this issue in that misalignments are considered either in absolute terms or averaged within the two sub-groups of positive and negative misalignments.

economies with very different saving rates in our panel, it is hence crucial to control for this country-specific factor. Moreover, the inclusion of the savings rate as a control variable also serves the purpose of testing the robustness of our results. Indeed, as highlighted by Woodford (2009) and Gonçalves and Rodrigues (2017), the savings rate may be a potentially confounding factor in the estimation of the REER misalignment-economic growth link, in that it is positively related to economic growth and negatively correlated to the REER. The expected sign of the coefficients attached to these two control variables is negative for the former and positive for the latter.[26]

The regressions also include a full set of country and time fixed effects (f_i, f_t), as is common in the existing growth literature, implying the estimation of the correlation between changes in REER misalignments and changes in GDP per capita growth rates within countries, when country-specific time-invariant factors (i.e. country fixed effects) are accounted for. Moreover, time fixed effects remove any common trends that can potentially co-move with the explanatory variables.

As an alternative estimation procedure to ordinary least squares (OLS) with fixed effects, we also run (two-step) system generalised method of moments (SGMM) regressions (developed by Arellano and Bond, 1991; Arellano and Bover, 1995; Blundell and Bond, 1998). The latter estimation method deals with various possible sources of endogeneity, including the presence of estimated regressors with a possible measurement error (in our case, REER misalignments) and of potential reverse causality. This procedure uses lagged values of regressors (in levels and in differences), which are considered uncorrelated with the fixed effects, as instruments for the endogenous right-hand-side variables and allows lagged endogenous (left-hand-side) variables as regressors.[27] SGMM has also been employed in a similar context in, for example, Aguirre

[26] In Annex E we discuss and check for further control variables, which turn out to be not statistically significant.

[27] As explained in Roodman (2009a), SGMM augments the so-called "difference GMM" – according to which estimation proceeds after first-differencing the data in order to eliminate the fixed effects – by simultaneously estimating two equations in differences and levels, where lagged variables in levels instrument the differenced equation and lagged differences instrument levels. SGMM is expected to outperform the GMM difference estimator when the instruments present a high degree of persistence, since in the latter cases lagged differences tend to be poor instruments. The system of two equations in a SGMM is treated as a single-equation estimation problem because the same linear relationship with the same coefficients is believed to apply to both the transformed and untransformed variables. Parameter identification is achieved by assuming that future realizations of the error term do not affect current values of the explanatory variables, that the error term is serially uncorrelated and that changes in the explanatory variables are uncorrelated with the fixed effects. The two-stage SGMM procedure refers to the fact that in the first-step regression the covariance matrix of the transformed errors is replaced by some reasonable but arbitrary estimate of the former, which generally assumes an i.i.d error structure. Residuals are then obtained from this first-stage regression and are employed to construct a cluster-robust proxy of the

and Calderón (2005), Gala (2008), Schröder (2013) and Grekou (2018). In our baseline SGMM estimates we treat all variables as endogenous with the exception of the time dummies, but lags are limited in order to keep the instrument count down relative to the number of observations.[28]

5.1.2 Baseline results

Baseline results are reported in Table 5. For OLS estimations the goodness of fit of all model specifications, as gauged by the adjusted R-squared, is satisfactory. The second-order tests for autocorrelation and the Hansen test for overidentifying restrictions suggest that the validity of the SGMM moment conditions cannot be rejected at conventional levels, thereby validating the SGMM regressions for inference.[29]

The conditional GDP convergence parameter is always statistically significant and correctly signed, such that, all things being equal, low-income countries tend to grow faster, thereby "catching up" the high-income countries. This parameter is larger under the OLS procedure than under SGMM, as found in Hauk and Wacziarg (2009). The savings rate variables also displays the expected positive coefficient.

With respect to the main variable of interest, REER misalignments (expressed in absolute value) are found to significantly dampen economic growth on average for all countries in the sample (cols. 1a and 1b). This aggregate result, may, however mask asymmetries. This does not appear to be the case for the sample of countries considered

covariance matrix, which accounts for potential correlation between countries' errors over time; the estimation is then rerun using the latter. The variance in the dependent variable is thus the ultimate source of the variance in the parameter estimates, which leads to severely downward-biased coefficient standard errors in two-step SGMM. Windmeijer (2005) devised a small-sample correction for the two-step standard errors to account for this issue, employed herein.

[28] Since for each time period we have a different number of instruments available (one for t=2, two for t=3 etc.), the number of instruments is quadratic in the total number of time periods. This may entail a cumbersome instrument count, which in turn can lead to overfitting of the endogenous variables and to weakening Hansen's (1982) J overidentification test results (Roodman, 2009b). In our case the number of time periods is fairly large (7), hence an unrestricted set of lags will introduce a huge number of instruments, with a possible loss of efficiency. For this reason, in our baseline specification we truncate the lags of the instrumented variables at one in first differences and at two in levels.

[29] The Arellano and Bond second-order correlation test points to the fact that the differenced residuals do not exhibit significant second-order serial correlation, such that first-order serial correlation in levels is excluded. When the equation is overidentified, that is when the number of excluded instruments exceeds that of the endogenous variables, as is the case in Table 5, we can test whether the instruments are uncorrelated with the error term, i.e. if the instruments are valid. The overidentifying restrictions may be tested via the commonly employed J statistic of Hansen (1982). This is a test of the joint hypotheses of correct model specification and the orthogonality conditions, which may be rejected either because the instruments are not truly exogenous (and are hence correlated with the error term), or because they are being incorrectly excluded from the estimated equation. The reported test cannot reject the null hypothesis, hence confirming the validity of the employed instruments.

in this paper: both over and undervaluations are found to be growth-threatening (cols. 2a and 2b), complying with recent results, for example, in Schröder (2013) and Comunale (2017).

Table 5. REER misalignments and economic growth

(dependent variable: annual average GDP per capita growth in 5-year periods)

	(1a) OLS	(1b) SGMM	(2a) OLS	(2b) SGMM
Initial real GDP per capita (ln)	-0.048***	-0.016***	-0.049***	-0.014***
	(0.011)	(0.003)	(0.010)	(0.003)
Absolute REER misalignment (5-yr mean; pctge. pts.)	-0.043***	-0.042***		
	(0.012)	(0.007)		
Positive REER misalignment (5-yr mean; pctge. pts.)			-0.064***	-0.086***
			(0.011)	(0.016)
Negative REER misalignment (5-yr mean; pctge. pts.)			0.036***	0.043***
			(0.013)	(0.011)
Gross domestic savings rate (5-yr mean; in pctge. of GDP)	0.091***	0.082***	0.098***	0.091**
	(0.028)	(0.027)	(0.027)	(0.038)
Adjusted R-squared	0.704		0.705	
Number of observations/number of countries	402/54	402/54	402/54	402/54
Number of instruments		68		88
Arellano and Bond test for AR(2) in first-differences		0.137		0.454
Hansen test of over-identifying restrictions		0.672		0.988

Notes: Country and time (Time) fixed effects are included in the OLS specifications (SGMM specifications), but here not reported. In the SGMM estimations all variables are treated as endogenous, except for the time dummies. To avoid excessive instrument proliferation, the lags of the instrumented variables are truncated at one in first differences and at two in levels in all specifications. Robust clustered standard errors are reported for OLS in brackets; in the case of two-step SGMM the errors are also subject to Windmeijer's (2005) correction. ***, ** and * denote statistical significance levels at 1, 5 and 10%, respectively. For the two tests, p-values are reported, when applicable.

These conclusions are robust to a set of checks, reported and discussed in Annex E. In particular, we conduct a "horse-race" exercise on alternatively deflated REER misalignments; we consider all explanatory variables, including REER misalignments, at the beginning of each period, instead of at their five-year averages; we drop the savings rate or we replace it with a financial market development index in the spirit of Prasad, Rajan and Subramanian (2007); we estimate a cross-sectional regression in which we drop fixed effects and include additional growth control variables; we trim our dataset to remove GDP growth or REER misalignment outliers; we change the number of instrument lags in the SGMM specifications; we split the sample between advanced and emerging economies. In the latter exercise baseline findings are broadly confirmed for both country groupings and, in particular, undervaluations are found not to be conducive to growth in emerging economies, running counter to Rodrik's (2008) findings. This difference will be further explored later on (see footnote 36).

5.1.3 Controlling for additional channels

A noteworthy point is that in these baseline regressions we are considering the relationship between REER misalignments and economic growth, regardless of the transmission channel. As in the next section we specifically focus on the inter-sectoral misallocation channel, here we further augment equation 9 to include three alternative channels via which REER disequilibria may operate, discussed in Section 2. In particular, we include – very loose admittedly (given the lack of data availability) – proxies for the share of FCD external debt, export diversification and within-sector production factor misallocation. The intuition is that if REER misalignments operate entirely through these channels, by controlling for them in the baseline regressions, the former could lose statistical significance.

In order to construct a measure of the share of FCD gross external debt, we retrieve information from the World Bank's Quarterly External Debt Statistics GDDS on both FDC and domestic currency external debt. Given that data are scanty over time, we employ the average FCD external debt share for the years available.[30] The export diversification channel is roughly proxied by import intensity (i.e. imports of goods as a share of GDP, based on IMF-WEO data), given that REER misalignments affect the price of imported goods employed for intermediate use and via this channel could impact production and exports.[31] Finally, in order to proxy for within-sector production factor misallocation for which internationally comparable firm-level data for our country-year sample are unavailable, we exploit the finding in the literature that financial factors may drive this variable (e.g. Midrigan and Xu, 2014; Gopinath et al., 2015; Gamberoni, Giordano and Lopez-Garcia, 2016; Schivardi, Sette and Tabellini, 2017). We capture these financial factors with credit to the private sector as a share of GDP, again sourced from IMF-WEO.

When running regression 10 controlling for these additional variables (Table 6), we cannot retain country fixed effects, given how the FCD external debt proxy is designed. Moreover, due to the decline in sample numerosity as a result of the limited

[30] For missing countries, we use data available for other countries that are economically similar (e.g. for euro-area countries whose data are missing, we employ the FCD external debt share for Germany).

[31] Sekkat (2016) builds direct export diversification indices on product-level international trade data, but both the time and country coverage is significantly more limited than that in this paper.

data availability to construct the additional variables, only initial GDP per capita and REER misalignments are treated as endogenous and hence instrumented in the SGMM regressions.

Table 6. REER misalignments and economic growth, with additional controls
(dependent variable: annual average GDP per capita growth in 5-year periods)

	(1a) OLS	(1b) SGMM	(2a) OLS	(2b) SGMM
Initial real GDP per capita (ln)	-0.012***	-0.019**	-0.012***	-0.015***
	(0.002)	(0.008)	(0.002)	(0.005)
Absolute REER misalignment (5-yr mean; pctge. pts.)	-0.017*	-0.032***		
	(0.009)	(0.009)		
Positive REER misalignment (5-yr mean; pctge. pts.)			-0.034***	-0.050***
			(0.010)	(0.015)
Negative REER misalignment (5-yr mean; pctge. pts.)			0.011	0.033**
			(0.008)	(0.014)
Gross domestic savings rate (5-yr mean; in pctge. of GDP)	0.074***	0.151***	0.069***	0.119**
	(0.013)	(0.045)	(0.013)	(0.049)
Foreign-currency-denominated external debt share (pctges)	0.001	-0.013	0.002	0.001
	(0.004)	(0.025)	(0.004)	(0.018)
Goods import share (5-yr mean; in pctge. of GDP)	0.004	-0.077	0.019	-0.025
	(0.033)	(0.103)	(0.033)	(0.096)
Private credit share (5-yr mean; in pctge. of GDP)	0	-0.002	0	-0.001
	(0.000)	(0.001)	(0.000)	(0.001)
Adjusted R-squared	0.682		0.686	
Number of observations/number of countries	276/38	276/38	276/38	276/38
Number of instruments		48		68
Arellano and Bond test for AR(2) in first-differences		0.788		0.815
Hansen test of over-identifying restrictions		0.846		0.999

Notes: Time fixed effects are included, but here not reported. In the SGMM estimations initial GDP per capita and REER misalignments are treated as endogeneous. To avoid excessive instrument proliferation, the lags of the instrumented variables are truncated at one in first differences and at two in levels in all specifications. Robust clustered standard errors are reported for OLS in brackets; in the case of two-step SGMM the errors are also subject to Windmeijer's (2005) correction. ***, ** and * denote statistical significance levels at 1, 5 and 10%, respectively. For the two tests, p-values are reported, when applicable.

Baseline findings concerning REER misalignments are confirmed, with the three new explanatory variables resulting statistically insignificant. Economic magnitudes involved are far from negligible: under the SGMM specification, a 10 percentage point REER misalignment is found to lower GDP per capita growth by around 0.2-0.3 percentage points.

All in all, we can conclude that REER misalignments do indeed (causally) affect economic growth. In particular, both positive and negative REER disequilibria are found to lower GDP growth, and hence we do not find support, in our country sample, of the claim that undervaluations could foster economic development. Ultimately, however, understanding the role of REER misalignments for growth requires stepping away from the aggregate growth-regression framework, looking at more disaggregated evidence to pin down relevant operating channels (Eichengreen, 2008; Berg and Miao, 2010). In the next section we hence directly investigate the link between REER misalignments and inter-sectoral production factor misallocation.

5.2 REER misalignments and inter-sectoral production factor misallocation

Our next regression of interest is the following:

$$(10)\ \overline{totec\_misalloc}_{i,t} = \alpha + \delta_1 gdppc_{i,t_0} + \delta_2 \overline{reermis}_{i,t} + \delta_3 \overline{savrate}_{i,t} + \varepsilon_{i,t}$$

where $\overline{totec\_misalloc}_{i,t}$ is the five-year average level of allocative inefficiency in the aggregate economy, REER misalignments are considered again both in absolute terms and then separately as over- and undervaluations, and all previous notation holds. Misallocation is measured by our two baseline indicators, namely the SDI and Aoki's measure of the dispersion in production factor frictions.

Table 7 reports results based again either on OLS or SGMM procedures. The former replicates the first-stage of a two-stage least squares (TSLS) procedure we will return to later;[32] the latter method better investigates causality. Each panel refers to a different allocative inefficiency measure.

Absolute REER misalignments are significantly and positively correlated with across-sector labour misallocation, however measured. In particular, in the OLS regression, both over- and undervaluations are found to go hand-in-hand with higher labour allocative inefficiency, implying a symmetric effect; the SGMM framework suggests that, if anything, it is an undervaluation that fosters labour misallocation, running counter to predictions in Rodrik (2008).[33]

Capital misallocation results, for which Aoki's measure is the only one available, are instead very weak, as both the adjusted R-squared and the F-statistics show, implying

[32] This also explains why the control variables in equation 10 are the same as those in equation 9.

[33] The adjusted R-squared, when applicable, is satisfactory, confirmed by the generally high Montiel Olea and Pflueger's (2013) F-statistics. The latter test is a rigorous heteroskedasticity, autocorrelation, and clustering-robust weak instrument test that tests the null hypothesis that the estimator's approximate asymptotic bias (the so-called "Nagar (1959) bias") exceeds a fraction of a "worst-case" benchmark, which coincides with the OLS bias when errors are conditionally homoscedastic and serially uncorrelated. The test rejects the null hypothesis when the "effective" F-statistic exceeds a critical value, in turn depending on the significance level (set at 5 per cent in our case) and the desired fraction of the worst-case bias (set at 30 per cent). One exception is the effective F-statistic in the case of the SDI being instrumented by the absolute REER misallocation, which suggests the latter is a weak instrument of the former.

no significant nexus of this type of misallocation with REER imbalances. This outcome is possibly due to the smaller number of countries for which capital data are available,[34] as well as to the lower quality of the latter. It may also reflect the fact that, relative to labour, capital presents a larger degree of irreversibility, and therefore reacts less to potential drivers such as changes in REER misalignments, shifting less easily across sectors.

In most regressions the initial level of economic development displays a statistically significant and negative sign. This control variable accounts for the fact, for example, that emerging economies have a higher level of labour misallocation, due to the over-employment in agriculture, prior to their process of structural transformation, as documented in Section 4. In the case of capital misallocation initial GDP per capita still enters the regression with a negative sign (yet only in the OLS regressions), but with a much smaller coefficient, owing to the fact that even advanced economies display high levels of this type of allocative inefficiency.

Table 7.
The link between REER misalignments and inter-sectoral misallocation

Panel A. Labour misallocation

	Dependent variable: SDI (nominal,5-yr mean)				Dependent variable: dispersion in labour frictions (5-yr mean)			
	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)	(4a)	(4b)
	OLS	SGMM	OLS	SGMM	OLS	SGMM	OLS	SGMM
Initial real GDP per capita (ln)	-0.062***	-0.045***	-0.064***	-0.059***	-0.064***	-0.036**	-0.064***	-0.045***
	(0.006)	(0.012)	(0.006)	(0.015)	(0.008)	(0.015)	(0.008)	(0.012)
Absolute REER misalignment (5-yr mean; pctge. pts.)	0.084**	0.065*			0.132**	0.147***		
	(0.027)	(0.038)			(0.039)	(0.050)		
Positive REER misalignment (5-yr mean; pctge. pts.)			0.116*	0.100			0.108**	0.070
			(0.052)	(0.076)			(0.042)	(0.075)
Negative REER misalignment (5-yr mean; pctge. pts.)			-0.081**	-0.104*			-0.129**	-0.162***
			(0.025)	(0.055)			(0.041)	(0.055)
Gross domestic savings rate (5-yr mean; in pctge. of GDP)	0.327***	0.429***	0.330***	0.461**	0.240***	0.358*	0.241***	0.414***
	(0.046)	(0.164)	(0.047)	(0.195)	(0.029)	(0.195)	(0.028)	(0.148)
Adjusted R-squared	0.379		0.380		0.392		0.390	
Number of observations/number of countries	360/54	360/54	360/54	360/54	360/54	360/54	360/54	360/54
Number of instruments		41		61		41		61
Standard F-statistic	120.66		83.87		50.61		46.74	
Effective F-statistic (critical value; 30% worst-case bias)	8.45 (12.04)		4.46 (3.00)		19.39 (12.04)		9.65 (3.00)	
Arellano and Bond test for AR(2) in first-differences		0.267		0.371		0.209		0.316
Hansen test of over-identifying restrictions		0.289		0.603		0.165		0.639

[34] This hypothesis is the least likely, since we show in Table E8 in Annex E that labour misallocation results are confirmed even for this smaller county sample, suggesting that sample selection does not drive the different findings between the two types of misallocation.

Panel B. Capital misallocation (Table 7 cont.)

	Dependent variable: dispersion in capital frictions (country-specific time-invariant capital shares; 5-yr mean)			
	(1a)	(1b)	(2a)	(2b)
	OLS	SGMM	OLS	SGMM
Initial real GDP per capita (ln)	-0.018**	-0.005	-0.017***	-0.019
	(0.005)	(0.014)	(0.005)	(0.015)
Absolute REER misalignment (5-yr mean; pctge. pts.)	-0.048	-0.067		
	(0.052)	(0.091)		
Positive REER misalignment (5-yr mean; pctge. pts.)			-0.153	-0.113
			(0.086)	(0.097)
Negative REER misalignment (5-yr mean; pctge. pts.)			0.026	-0.013
			(0.053)	(0.107)
Gross domestic savings rate (5-yr mean; in pctge. of GDP)	0.154	0.254	0.061	-0.086
	(0.121)	(0.231)	(0.158)	(0.280)
Adjusted R-squared	0.011		0.019	
Number of observations/number of countries	203/35	203/35	203/35	203/35
Number of instruments		41		61
Standard F-statistic	5.24		0.01	
Effective F-statistic (critical value; 30% worst-case bias)	0.74 (12.04)		0.04 (3.00)	
Arellano and Bond test for AR(2) in first-differences		0.214		0.092
Hansen test of over-identifying restrictions		0.775		1.000

Notes: In the SGMM estimations all variables are treated as endogenous. To avoid excessive instrument proliferation, the lags of the instrumented variables are truncated at one in first differences and at two in levels in all specifications. Robust clustered standard errors are reported for OLS in brackets; in the case of two-step SGMM the errors are also subject to Windmeijer's (2005) correction.***, ** and * denote statistical significance levels at 1, 5 and 10%, respectively.

Finally, in Table E9 in Annex E we replace the dependent variable of equation 10 alternatively with one of the three rough proxies of other possible channels of influence of REER misalignments. REER imbalances, and in particular undervaluations, are found to be significantly and causally correlated only with the FCD external debt share (as in Grekou, 2018).

5.3 REER misalignments, inter-sectoral labour misallocation and economic growth

5.3.1 Baseline results

At this stage, although we have found a robust and causal nexus between REER misalignments and inter-sectoral labour misallocation, the jury is still out on whether this is the only channel via which these external imbalances affect economic development.

To delve deeper into this issue, we first provide results of a "second-stage" of a TSLS regression, after the first stage estimated in equation 10, which has the following form:

$$(11)\ \overline{\Delta gdppc}_{i,t} = \alpha + \gamma_1 gdppc_{i,t_0} + \gamma_2 \overline{totec\_misalloc}_{i,t} + \gamma_3 \overline{savrate}_{i,t} + \varepsilon_{i,t}$$

where the misallocation measures are instrumented by contemporaneous REER misalignments, both in absolute terms and distinguishing between positive and negative imbalances, and previous notation holds. This second-stage regression crucially hinges on the assumption that REER misalignments only affect GDP per capita growth via the inter-sectoral misallocation channel.

Higher labour misallocation exerts a statistically significant drag on growth when instrumented by both positive and negative REER misalignments, whichever the measure employed (Table 8). Test statistics are found to be satisfactory.[35] Unsurprisingly, labour misallocation does not significantly affect economic activity when instrumented by absolute REER imbalances, given the weak relationship found in the first stage in Table 7 (see footnote 33).

When the equation is overidentified, that is when the number of excluded instruments exceeds that of the endogenous variables, as in columns b, we can test whether the instruments are valid (otherwise the commonly employed J statistic is zero for any identically-identified equation and hence not reported). The J statistic fails to reject the null hypothesis of orthogonality of the instruments with respect to the error term, hence suggesting that the labour misallocation channel is indeed the only one via which REER misalignments affect economic growth, a point we will come back to in the following subsection.[36]

Unsurprisingly, second-stage results for capital misallocation are inconclusive, given the results for the first-stage regressions, and are reported in Table 8 only for the sake of completeness. While this outcome might reflect the smaller sample and the larger measurement error for capital misallocation, it is broadly consistent with Benigno, Converse and Fornaro's (2015) finding that whereas a greater reallocation of employment away from manufacturing during a capital inflow/REER appreciation episode is significantly associated with a more severe recession afterwards, by contrast, there is no systematic relationship between the share of investment allocated to manufacturing during episodes of large inflows and subsequent economic performance.

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[35] Findings based on the nominal SDI are also confirmed if the real SDI is employed both in the first and second stage regressions (results available upon request).

[36] As our results concerning undervaluations again run counter to those in Rodrik (2008), in Table E7 in Annex E we test whether this could be due to the different country sample. In particular, we focus solely on the emerging economies in our sample, and estimate regressions 11 and 12 by employing the share of employment in non-tradable sectors (as defined in Section 4.1) as a simple proxy of misallocation, following from Rodrik's (2008) model. Also via this exercise we exclude that REER undervaluations are conducive to higher economic growth, both in the full country sample and when focusing solely on emerging economies. Plausibly, this growth-enhancing effect is hence only relevant for economies that have a very low income, here not considered.

Table 8.
The link between REER misalignments and economic growth via the inter-sectoral misallocation channel
(dependent variable: average annual GDP per capita growth in 5-year periods)

	Labour misallocation				*Capital misallocation*	
	Underlying misallocation measure: SDI (nominal,5-yr mean)		Underlying misallocation measure: dispersion in labour frictions (5-yr mean)		Underlying misallocation measure: dispersion in capital frictions (country-specific time-invariant capital shares; 5-yr mean)	
	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)
Initial real GDP per capita (ln)	-0.031***	-0.035***	-0.027***	-0.030***	-0.016**	-0.01
	(0.010)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Across-sector production factor misallocation (5-yr mean)	-0.223	-0.287***	-0.147	-0.178*	0.097	0.429
	(0.148)	(0.108)	(0.103)	(0.101)	(0.419)	(0.426)
Gross domestic savings rate (5-yr mean; in pctge. of GDP)	0.153***	0.175***	0.115***	0.119***	0.059	0.027
	(0.047)	(0.032)	(0.027)	(0.027)	(0.054)	(0.065)
Adjusted R-squared	0.681	0.617	0.789	0.757	0.398	0.292
Number of observations/number of countries	360/54	360/54	360/54	360/54	203/35	203/35
Number of excluded instruments	1	2	1	2	1	2
Hansen J test of over-identifying restrictions	-	0.528	-	0.176	-	0.185

Notes: Two-step feasible GMM TSLS are employed. The first column of each proxy is based on one instrument (the absolute value of REER misalignments), the second column on two instruments (positive and negative REER misalignments). Robust and clustered standard errors are reported in brackets. ***, ** and * denote statistical significance levels at 1, 5 and 10%, respectively.

5.3.2 Further assessing the relevance and uniqueness of the inter-sectoral labour misallocation channel

As regards the economic magnitudes derived from Table 8, a 10 per cent REER misalignment of either sign is estimated to raise the two inter-sectoral labour misallocation indicators roughly one for one, in turn shaving off around 0.2-0.3 percentage points of real GDP per capita growth. This figure is hence of the same order of magnitude of that resulting from Table 6, measuring the direct relationship between REER misalignments and economic development, controlling for all potential channels. It could be, however, that other channels are operating, yet simply offsetting each other.

In order to further document the uniqueness of the labour misallocation channel, we draw upon the results in Table E9 that show that, amongst the three alternative channels, REER imbalances are not weak instruments only of FCD external debt, and perform a second-stage regression in which both labour misallocation and FCD external debt are instrumented by positive and negative REER misalignments (and by the lags of other included exogenous regressors, in order to have sufficient instruments; Table 9). Only the labour misallocation channel, however measured, is statistically significant. In particular, REER misalignments are significantly found to stifle GDP per capita growth via the labour misallocation channel, again by approximately 0.2-0.3 percentage points.

Table 9. The link between REER misalignments and economic growth via the inter-sectoral labour misallocation and the foreign currency-denominated external debt share channels

(dependent variable: average annual GDP per capita growth in 5-year periods)

	Underlying misallocation measure:	
	SDI (nominal, 5-yr mean)	dispersion in labour frictions (5-yr mean)
	(1a)	(1b)
Initial real GDP per capita (ln)	-0.035***	-0.040***
	(0.004)	(0.004)
Across-sector labour misallocation (5-yr mean)	-0.286***	-0.324***
	(0.069)	(0.056)
Foreign-currency-denominated external debt share (pctges)	0.012	-0.002
	(0.014)	(0.014)
Gross domestic savings rate (5-yr mean; in pctge. of GDP)	0.141***	0.189***
	(0.017)	(0.018)
Adjusted R-squared	0.535	0.481
Number of observations/number of countries	319/54	319/54
Number of excluded instruments	4	4
Hansen J test of over-identifying restrictions	0.239	0.452

Notes: This is the second-stage regression of a two-step feasible GMM TSLS procedure. Labour misallocation and the foreign currency-denominated external debt share are instrumented by positive and negative REER misalignments, the lagged initial GDP per capita level and the lagged mean savings rate. Robust and clustered standard errors are reported in brackets. ***, ** and * denote statistical significance levels at 1, 5 and 10%, respectively.

Finally, the uniqueness of the labour misallocation channel is also confirmed by back-of-the-envelope calculations based on Dabla-Norris et al. (2015), from which we can derive the quantitative nexus between inter-sectoral labour allocative inefficiency and real growth. According to Dabla-Norris et al. (2015), the elimination of inter-sectoral labour inefficiency in a panel of advanced economies would raise the average total factor productivity (TFP) level by nearly 5 per cent. By employing this figure and by assuming that changes in TFP map one-to-one into real GDP per capita developments,[37] the elimination of average labour misallocation across all countries and years of our dataset[38] would boost average annual GDP per capita growth by approximately 0.2 percentage points. Given this order of magnitude, based on the estimated SGMM coefficients in the upper panel of Table 7 and assuming that the misallocation-growth relationship is symmetric, the deterioration in labour misallocation due to a 10 percentage point REER

[37] This implies the assumption that labour participation rates and capital deepening are both held constant.

[38] Average total-economy labour misallocation in our panel is approximately 0.2 (in a range between 0 and 1, as discussed in Section 4), whichever the measure employed.

misalignment would lead to a drag on real growth in a range of 0.1 (according to the SDI) and 0.2 (according to Aoki's labour friction measure) percentage points. Considering that Dabla-Norris et al. (2015) employs the second proxy to measure labour allocative inefficiency and only considers advanced economies (for which the contribution of inter-sectoral misallocation to growth is more contained relative to emerging countries, as documented in many studies), the upper side of our range is the most reliable, and fits squarely with the direct estimations based on the two-stage regressions reported herein.

6. Conclusions

This paper investigates the nexus between REER misalignments and real growth in a panel of 54 medium and high-income countries since 1980. In addition to simply estimating the direct link between these two variables, as done by the prevalent literature, thereby capturing all possible channels of influence, this study adopts a two-stage approach in order to examine the relevance and uniqueness of the channel of production factor misallocation across sectors. Indeed, REER misalignments of both signs may distort the relative size of sectors, to the detriment of the most productive. Rodrik (2008) has, however, brought evidence to the fact that REER misalignments may operate asymmetrically in low-income economies: whereas overvaluations are universally harmful, undervaluations can be found to be conducive to growth, since they increase the size of the highly productive, tradable manufacturing sector, which otherwise would be sub-optimally small due, for example, to weak institutional quality.

Relative to Rodrik (2008) and also owing to a more restricted country sample, this paper employs both a more sophisticated indicator of REER misalignments – in turn based on a fully-fledged Behavioural Equilibrium Exchange Rate model (fully detailed in Giordano, 2021) – and more accurate measures of inter-sectoral misallocation developed by the more recent productivity literature. In particular, to this end we construct a novel dataset of inter-sectoral labour and capital misallocation across 12 sectors, based on indicators put forward by Ando and Nassar (2017) and by Aoki (2012). Moreover, this paper complements Rodrik's (2008) study, as it focuses solely on the more developed economies world-wide, which broadly overlap with those underlying the IMF's External Balance Assessment (EBA). Finally and differently to Rodrik (2008), we implement various tests and exercises to evaluate the uniqueness of the inter-sectoral production factor misallocation channel via which REER imbalances affect economic growth and to explicitly exclude other channels suggested by the empirical literature, namely the foreign-currency denominated share (FCD) of external debt (Grekou, 2018), export diversification (Sekkat, 2016) and within-sector production factor misallocation.

We find that in our country sample both REER over- and under-valuations stifle real growth and that the effects of REER misalignments on growth significantly and uniquely operate through the associated change in the degree of labour (but not capital) misallocation across sectors, corroborating the literature that implicitly suggested this channel as being highly relevant. In particular, a 10 percentage point REER misalignment is estimated to shave off around 0.2 percentage points of annual real GDP per capita growth by exacerbating inter-sectoral labour misallocation. Albeit by employing very rudimentary proxies due to data availability linked to our large county-year sample, we can exclude that other channels via which REER misalignments may affect economic development (i.e. the FCD external debt burden, export diversification and within-sector production factor misallocation) are at play in our panel of countries, in the same or in offsetting directions. All these channels should, however, be investigated in future research for low-income economies, not considered herein.

From a policy perspective, the results of this paper confirm the fact that systematic REER under- and overvaluations should be a cause of concern for policy-makers of medium and high-income economies, and thus require close monitoring, since they distort the size and productivity of economic sectors, and ultimately significantly hurt growth. In this regard, exercises such as the EBA – which measures external imbalances for a given set of countries on an annual basis – is very useful in the detection of harmful REER disequilibria of both signs. In order to reduce REER misalignments – in addition to changes in the nominal exchange rate, which are not always a policy tool according to the adopted currency regime – there is a significant role for country-specific structural reforms (as discussed, for example, in Fidora, Giordano and Schmitz, 2021), which remove price and wage rigidities and strengthen domestic economic fundamentals, hence narrowing down the REER misalignments and reducing their growth-threatening effect, as well as boosting economic development *per se*.

Annex A. Some details of the BEER model

Table A1. The list of countries

Advanced economies	Emerging economies
Austria (AT)*	Algeria (DZ)**
Australia (AU)*	Argentina (AR)*
Belgium (BE)*	Brazil (BR)*
Canada (CA)*	Bulgaria (BG)
Cyprus (CY)*	Chile (CL)*
Czech Republic (CZ)*	China (CN)*
Denmark (DK)*	Croatia (HR)
Estonia (EE)*	Hungary (HU)*
Finland (FI)*	India (IN)*
France (FR)*	Indonesia (ID)
Germany (DE)*	Malaysia (MY)
Greece (GR)*	Mexico (MX)*
Hong Kong (HK)	Morocco (MA)
Iceland (IS)	Philippines (PH)
Ireland (IE)*	Poland (PL)*
Israel (IL)	Romania (RO)
Italy (IT)*	Russian Federation (RU)
Japan (JP)*	South Africa (ZA)
Korea, Republic of (KR)*	Thailand (TH)
Latvia (LV)*	Turkey (TR)
Lithuania (LT)*	
Luxembourg (LU)*	
Malta (MT)	
Netherlands (NL)*	
New Zealand (NZ)	
Norway (NO)	
Portugal (PT)*	
Singapore (SG)	
Slovakia (SK)*	
Slovenia (SI)*	
Spain (ES)*	
Sweden (SE)*	
Switzerland (CH)	
United Kingdom (GB)*	
United States (US)*	

Notes: Countries flagged with one asterisk are those for which capital data are available, as discussed in Section 4.1. Algeria, flagged by two asterisks, is included in the BEER model, and hence as a trading partner of all other countries, but is not included in the dataset described in Section 4.1, due to the lack of sectoral national accounts.

In the BEER model literature there is no prior theory for the selection of economic fundamentals driving the RER; hence, the choice of the determinants of the RER is based on economic intuition, data availability and statistical selection procedures.

One of the most popular explanations of the deviations of RERs from equilibrium is due to Balassa (1964) and Samuelson (1964), which posited that relative prices of non-traded and traded goods are inversely related to the relative productivity in the two sectors. A rise in productivity in the tradable sector entails an increase in wages in the same sector, yet also bids up wages in the non-tradable sector, leading to a higher general price level, which in turn implies a RER appreciation. As mentioned earlier, this determinant is the only one taken into account by Rodrik (2008), yet several other drivers have been pinpointed in the relevant literature.

First, lower trade barriers can lead to RER depreciation via a fall in domestically produced goods' prices, in turn due to heightened competition or to cheaper intermediate inputs (Goldfajn and Valdes, 1999; Ricci, Milesi-Ferretti and Lee, 2013). Second, an improvement in terms of trade should bring about a positive income or wealth effect in the domestic economy; the ensuing rise in domestic demand for non-tradables increases domestic non-tradable prices and therefore leads to a RER appreciation (Neary, 1988). Third, in intertemporal optimizing models (Obstfeld and Rogoff, 1996; Lane and Milesi-Ferretti, 2004), a net external debt produces a negative wealth effect that lowers consumption and the demand for home goods, as well as raising labour supply. The combined effect of a decline in consumption of non-tradables and a higher labour supply to the non-traded sector leads to a depreciation in the relative price of non-tradables and hence of the RER. Fourth, final government consumption can positively affect the RER through a composition effect (Froot and Rogoff, 1992; Obstfeld and Rogoff, 1996; Hinkle and Montiel, 1999): because government consumption tends to fall disproportionately on domestic non-tradables, the RER tends to rise as a result of a surge in this demand component. However, excessive government consumption, and therefore spending, may cast doubt on the sustainability of fiscal policy and undermine the confidence in a country's currency, leading to RER depreciation (Frenkel and Mussa, 1985; Melecký and Komárek, 2007). The expected correlation between government consumption and the RER is therefore *a priori* ambiguous. Fifth, demographics may affect the RER (e.g. Giagheddu and Papetti, 2020). Under the life-cycle hypothesis, lower labour participation or a higher old-age dependency (OAD) ratio can lead to a more appreciated RER. In particular, the elderly consume more non-traded services relative to working-age people, implying an increase in overall demand for those goods in the presence of population ageing (Groneck and Kaufman, 2017). At the same time, the old-age population has lower saving rates than younger cohorts, such that aggregate savings of an ageing society decline (Higgins, 1998; Yoon, Kim and Lee, 2014) and aggregate consumption increases, again biased towards non-tradable goods. If the additional demand for non-traded services of an ageing society is not fully met by higher supply, the relative price of non-tradables increases and the RER appreciates. Sixth, the investment rate, which can proxy for technical progress, may lead to productivity rises and therefore to a RER appreciation

(Bussière et al., 2010). However, given investment's high import content, it may also affect the trade balance negatively, with an opposite impact on the RER. Seventh, an (unanticipated) increase in real interest-rate differentials should give rise to capital inflows and therefore to a RER appreciation (Adler and Grisse, 2017). Finally, (de-trended) credit to the private sector as a share of GDP has been employed as an indirect indicator of financial excesses, which may cause demand booms, leading to RER appreciation (Cubeddu et al., 2019).

To empirically investigate the Balassa-Samuelson effect, we use three alternative proxies: (i) relative GDP per capita, as is standard in most of the BEER model and growth literature (e.g. Aguirre and Caldéron, 2005; Hassan, 2016; Couharde et al., 2017); (ii) relative labour productivity, measured as output per worker (as in Fidora, Giordano and Schmitz, 2021): (iii) relative tradable/non-tradable labour productivity, a novel measure (also relative to Giordano, 2021) based on the dataset described in Section 4.1 of this paper. In order to measure trade costs, we employ the so-called "phi-ness" indicator of trade, put forward by Head and Ries (2001), Baldwin et al. (2003) and Head and Mayer (2004). It covers all costs involved in trading goods internationally relative to those involved in trading goods domestically. At the time of writing of this paper, this measure – sourced from the ESCAP-WB Trade Cost Database, then trade-weighted so as to move from a bilateral to an effective indicator vis-à-vis all trading partners – was available only for the years 1995-2015; for the missing years it is spliced with a standard openness to trade indicator, expressed as the ratio of the sum of imports and exports to GDP. The other economic fundamentals are constructed in a standard fashion based on national account or financial data retrieved from various sources (IMF WEO and IFS, OECD, BIS, World Bank WDI). Demography is captured by the OAD ratio. The private-credit to GDP ratio is de-trended using traditional Hodrick-Prescott filtering techniques in order to gauge any financial excesses, as is standard in the financial economics literature.

In order to select the economic fundamentals to be actually included in the BEER model, we estimate regressions for all possible combinations of the above-mentioned explanatory variables, using Bayesian model averaging techniques, as in Magnus, Powell, and Prüfer (2010). Since real interest rates, net foreign assets and private credit display a high (greater than 0.5) posterior inclusion probability only in maximum two models, we exclude these variables from the baseline BEER model, and retain the remainder.

Table A2. The variables in the BEER model: sources and details

	Notes	*Sources*
1. Dependent variable		
Nominal exchange rates	Relative to the US dollar. Deflated with one of the following five indicators.	IMF WEO
CPI		ECB, IMF WEO, BIS
PPP	The IMF WEO series are rescaled with the time-varying PPP series of the United States sourced from the Penn World Tables, for the years available (until 2014).	IMF WEO; Penn World Tables
GDP deflator		ECB, IMF WEO and IFS, World Bank WDI
PPI	Available for 53 countries.	Bank of Italy
ULCT	Available for 38 countries and since 1995.	ECB
2. Explanatory variables		
GDP per capita	PPP-based.	IMF WEO
GDP per worker	Computed as the ratio of PPP GDP to headcount employment.	IMF WEO and IFS, World Bank WDI
Tradable to non-tradable GDP per worker ratio	See Section 4.1 of this paper for sources and methodology.	
Phi-ness indicator	The bilateral indicator, sourced from ESCAP-WB Trade Cost Database, is weighted with the trade weights employed to construct the REER. Available for 1995-2015. For the remaining years it is interpolated with the trade openness variable.	ESCAP-WB Trade Cost Database, ECB, IMF-WEO
Trade openness	Computed as the sum of current-price total exports and total imports as a share of current-price GDP.	IMF-WEO
Terms of trade	Terms of trade index when available, otherwise computed as the ratio of the export unit value index to the import unit value index.	IMF WEO and IFS, World Bank WDI
Government consumption	Computed as the ratio of current-price government consumption to current-price GDP.	IMF WEO and IFS, World Bank WDI, OECD
Investment rate	Computed as the ratio of current-price gross fixed capital formation to current-price GDP.	IMF WEO and IFS, World Bank WDI
Old-age dependency ratio	In percentage of working-age population.	World Bank WDI
Net foreign assets	In US dollars.	Lane and Milesi-Ferretti (2018) and IMF IFS
Real interest rate	Computed as the nominal interest rate deflated by the CPI inflation rate.	IMF WEO and IFS, World Bank WDI, BIS
Private sector credit	Computed as the ratio of bank credit to the private sector in US dollars to current-price GDP in US dollars, detrended via the Hodrick-Prescott filter.	BIS, IMF WEO
3. Other		
Trade weights	3-year average import and double export weights vis-à-vis 54 trading partners.	ECB

Panel unit root test results point to the non-stationary nature of several variables in the BEER model, which are found to be cointegrated with the RER, according to panel cointegration tests. Moreover, there is evidence of strong cross-section dependence across the countries in the sample.

The common correlated effects mean group (CCEMG) outlier-robust coefficients obtained from estimating equation 1 in Section 3 are reported in Table A3, where each column refers to an alternative proxy of the Balassa-Samuelson effect. This effect, however measured, is always statistically significant at conventional confidence intervals and presents the expected positive sign. All other results too comply with the economic priors discussed earlier. In particular, an increase in the terms of trade, in trade costs and in the investment rate are all associated with a (less than proportional) real appreciation. When it is statistically significant, the long-run elasticity of government expenditure is positive, thereby confirming the compositional bias of public spending towards the non-tradable sector. Finally, also the OAD ratio is generally found to be positively related to RERs.

Goodness-of-fit statistics are comparable across the three specifications. In this paper we focus on the GDP per capita proxy of the Balassa-Samuelson effect as it is available for the highest number of country-years.[39]

Table A3. BEER model estimates

(dependent variable: PPP-deflated RER)

	Alternative Balassa-Samuelson proxy:		
	1	*2*	*3*
A.	GDP per capita	Total-economy labour productivity	Tradable to non-tradable labour productivity ratio
Balassa-Samuelson proxy	0.464***	0.289**	0.101*
	0.132	0.117	0.060
Trade costs	0.420***	0.356***	0.257***
	0.063	0.061	0.079
Terms of trade	0.733***	0.845***	0.933***
	0.140	0.132	0.145
Government consumption	1.262***	1.240***	0.640
	0.460	0.374	0.547
Investment rate	0.062	0.366*	0.857***
	0.226	0.197	0.217
Old-age dependency ratio	3.282*	3.650**	1.740
	1.992	1.791	1.784
Number of observations	*1923*	*1866*	1553
Number of countries	*54*	*54*	*53*
RMSE	*0.072*	*0.064*	*0.063*
Normalised RMSE	*0.014*	*0.013*	*0.013*

Source: author's estimates.

Notes: Outlier-robust estimates obtained with a CCEMG estimator for the period 1980-2017 on the country sample excluding the US. The specifications also include country fixed effects and cross-section means, here not reported. Standard errors are reported in small font. *** p<0.01, ** p<0.05, *p<0.1. The normalised root mean squared error (RMSE) is obtained by dividing the RMSE by the (min-max) range of the dependent variable.

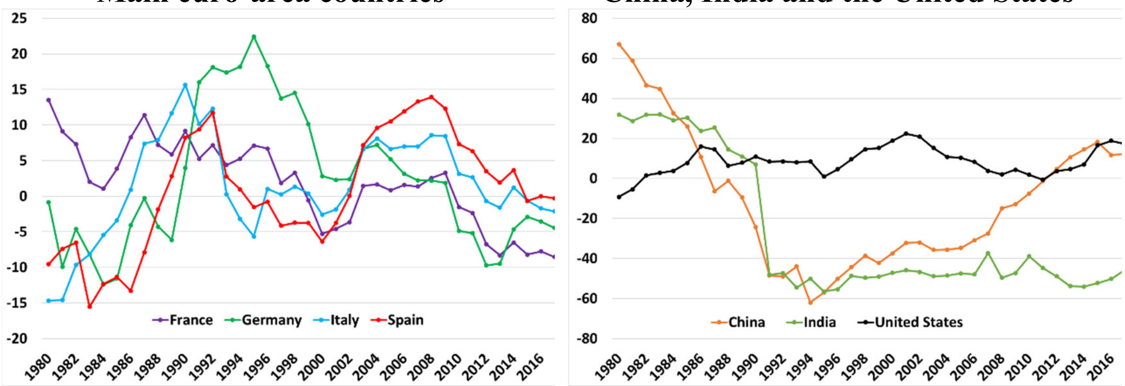
[39] In particular, the tradable/non-tradable labour productivity ratio is only available for the whole sample of countries until 2010. Results available upon request anyhow point to similar developments in misalignments based on the three different Balassa-Samuelson effect measures for all countries; similar conclusions were drawn on a quarterly dataset in Fidora, Giordano and Schmitz (2021), based on the first two proxies.

In Figure A1 we plot REER misalignments of selected countries (the four main euro-area countries, China, India and the United States). The REER disequilibria in the first four economies were significantly more contained than those in the other three, as shown by the different scales employed in the two panels; this is consistent with recent evidence, for example, in Fidora, Giordano and Schmitz (2021). Germany is a significant outlier within the euro area since, also owing to labour market reforms, its large overvaluation in the first half of the 1990s was reabsorbed as of the second half, to then become a significant undervaluation. Conversely, the other three euro-area countries, and Spain in particular, recorded a growing REER overvaluation after 1999, which was narrowed down only in the most recent, post-GFC years. Relative to the non-euro area countries, China's REER imbalances marked a clear U-shape, passing from over- to under- to overvaluation once again,[40] whereas India turned from strong overvaluation to significant undervaluation (triggered by a sharp nominal exchange rate depreciation in the 1990s), similarly to findings in Cheung, Steinkamp and Westermann (2020). The United States' REER was on average either broadly in line or moderately overvalued throughout the whole period.[41]

Figure A1. PPP-deflated REER misalignments

(percentage points)

Main euro-area countries **China, India and the United States**



Source: author's estimates.

[40] In 2005 China modified its exchange rate policy from a *de facto* dollar peg to a "managed floating exchange rate regime", which put the renminbi on a gradual appreciation path.

[41] The plotted PPP-deflated misalignments are point estimates, around which country-specific confidence intervals are to be envisaged. These estimates are broadly comparable with those published by CEPII in its EQCHANGE database, as well as with REER misalignments based on alternative price and cost deflators (Giordano, 2021).

Annex B. Additional details on the inter-sectoral production factor misallocation dataset

Table B1 provides the details of the reconstruction of the VA, employment, capital stock and capital compensation variables that are necessary to measure inter-sectoral production factors misallocation according to the proxies explained in Section 4.

In general, for the 28 EU countries and the United States we employ the July 2018 release of the EU KLEMS database, which generally covers the 1995-2015 period and is classified according to the ISIC Rev.4/NACE Rev. 2 industry coding. In order to lengthen the coverage back to 1980, previous vintages of EU KLEMS are employed, and reclassified accordingly. In order to expand the country sample size also to non-EU – advanced and emerging – economies, additional KLEMS databases, the GGDC 10-sector Productivity Database and the OECD STAN Database are used, again reclassifying sectors according to the NACE Rev. 2 coding.

Some of the 12 1-digit sectors employed listed in Table 2 were constructed by aggregating the available subsectors. This was the case, for example, for manufacturing in Canada and India and for wholesale and retail trade in Canada, China, India and Korea. In this case, nominal variables are obtained by addition, and index variables were constructed by employing the average growth rates of the subsectors. Conversely, LA KLEMS data for Latin American countries are available at an even less disaggregated breakdown. In particular, G+I, H+J and K+L sectors are only available respectively combined. To split them, nominal variable series are divided by two and assigned in equal amount to each component sector; the overall average growth rate is applied to the index variables of each component sector.

Amongst the further corrections made, it is noteworthy that in the various KLEMS databases some real variables are provided only as indices. In order to obtain the volume series the corresponding current-price series are extrapolated, backward and forward from their base-year value (redefined as 2005 for all variables and countries), using the annual growth rates derived from the index series. Moreover, in some KLEMS datasets VA is not available, so it is obtained in nominal terms by subtracting intermediate inputs from gross output (GO), both at current prices. Any negative VA values are dropped. In order to obtain real VA, first the GO deflator is derived as the ratio of nominal to real GO and then real VA is derived by deflating nominal VA by the computed GO deflator. Furthermore, capital stock data is sometimes provided for individual assets but not overall: total nominal capital stock is derived by summing all assets. When only nominal capital stock is available (as, for example, India), it is deflated with the VA deflator, in turn obtained by the ratio of nominal to real VA, in order to obtain the real capital stock. In order to compute capital frictions, as described in Section 4.4, nominal capital shares are necessary: they are assumed equal to real capital shares when the nominal shares are missing.

Similarly to Mano and Castillo (2015), real labour productivity of sector *i* at time *t* can be constructed as:

$$(C1)\ LP_{it} = \frac{RVA_{it}PPP_{2005}}{L_{it}}$$

where $RVA_{it} = \frac{VA_{it}}{PVA_{it}}$ is real VA in 2005 local currency units (LCU) constant prices, VA is nominal VA in LCU, PVA is the price index of VA using 2005 as the base year, L is employment and $PPP_{2005} = \frac{e_{usd/LCU,2005}}{PLI_{i,2005}}$, where $e_{usd/LCU,2005}$ is the average nominal exchange rate of USD per LCU in 2005 and $PLI_{i,2005}$ is the price level index of gross output (GO) of sector i in 2005 in units of the US GDP deflator. By expressing VA in constant PPP US dollar terms, current VA is adjusted for changes of prices over time, as well as for differences in 2005 price levels across countries and sectors, thus making our series fully comparable across countries and sectors over time.

Ideally, VA (as opposed to GO) PLIs should be used, but they are not available at the sectoral disaggregation of interest. We hence proceed in different stages. All real VA series are first rebased and expressed in 2005 constant price terms. To convert these series into 2005 PPP US dollar terms, we next employ Inklaar and Timmer's (2014) sectoral 2005 GO PPP rates, which are available for 42 countries. For the remaining 12 countries[42] we use the total-economy 2005 PPP rate sourced from IMF-World Economic Outlook. As a robustness check, we also construct an alternative 2005 VA (not GO) PPP rate series based on the macro-sectors provided in Inklaar and Timmer (2014). In particular, of these four macro-sectors (Manufacturing, Other Goods, Market Services and Non-Market Services) we drop the latter, since the public sector is not included in our analysis, as discussed earlier. Our 12 sectors in Table 2 are then easily mapped to the remaining three macro-sectors.

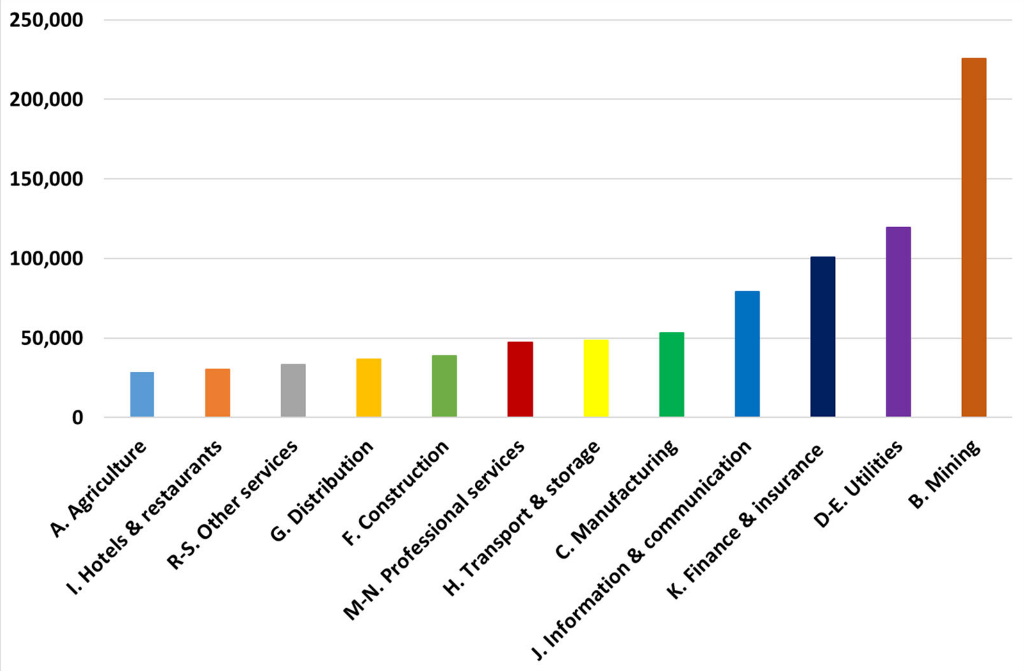
[42] These countries are Croatia, Hong Kong, Iceland, Israel, Malta, Malaysia, Norway, New Zealand, the Philippines, Singapore, Switzerland and Thailand.

To our knowledge the only comparable national account dataset to ours is that assembled by Mano and Castillo (2015). The two datasets have a similar country coverage, yet ours displays a slightly longer time coverage (1980-2015, as opposed to 1989-2012). The main differences are, however, that Mano and Castillo's (2015) dataset uses World Input-Output Database as the main source, in turn based on an older industry classification (ISIC Rev. 3, which corresponds to NACE Rev.1) and that it does not include capital stock data.

Based on our data, Figure B1 reports the 1980-2015 average levels of real labour productivity in PPP terms by sector.[43] Agriculture presents the lowest level of labour productivity across all sectors. Conversely, industrial sectors stand out as generally recording higher levels of labour productivity than services, especially in the cases of mining and utilities. Minerals and natural resources indeed generally operate at high levels of labour productivity since they absorb low levels of employment, and utilities are highly capital-intensive (McMillan and Rodrik, 2011). Labour productivity in manufacturing is significant, but lower than that in information and communication and in finance and insurance. Construction's labour productivity is comparable to that of other services sectors, namely hotels and restaurants, distribution and "personal services" (i.e. professional services and other services) and only mildly higher than that in agriculture. Although averaged across a large bundle of countries, these results confirm the fact that, the treatment of services as a homogeneous, stagnant (and non-tradable) sector, as opposed to dynamic manufacturing, is not justified by the empirical evidence, as already found, for example, in Timmer, Inklaar and O'Mahony (2010) and Jorgenson and Timmer (2011). Moreover, a tradable sector such as agriculture displays the lowest level of productivity.

[43] A thorough analysis of VA or employment shares and of labour productivity growth rates goes beyond the scope of this paper; recent stylised facts for advanced economies may be found in Jorgenson and Timmer (2011), which uses EU KLEMS data, and Gordon and Sayed (2019), which uses both US and EU KLEMS data, and for emerging economies Timmer, de Vries and de Vries (2015), which uses the GGDC Productivity Database. In these sectoral comparisons, one must always be aware, however, of the larger measurement error in VA, and therefore of productivity, of services (Griliches, 1992) and of agriculture (Herrendorf and Schoellman, 2015). Finally, by using the VA PPP rate by macro-sector (as opposed to the GO PPP rate by sector) the sectoral ranking of real labour productivity of Figure C1 is confirmed.

Figure B1. Average levels of real labour productivity by sector, 1980-2015
(2005 PPP USD-adjusted levels; averages across countries and years)



Source: author's estimates.
Notes: Labour productivity is computed as real 2005 PPP-adjusted VA per worker. Averages are taken across those countries for which sectoral GO PPP rates are available, namely those reported in Inklaar and Timmer (2014). The full names of the sectors are reported in Table 2.

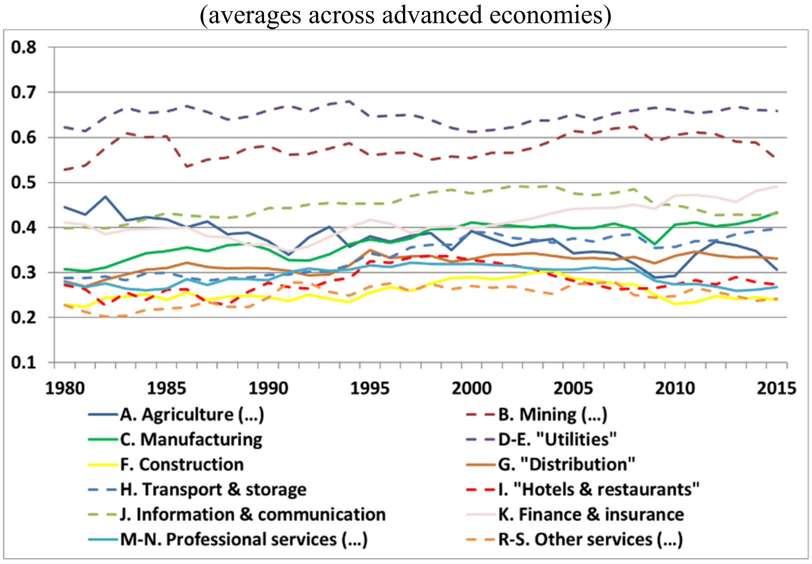
As concerns sectoral capital stock, it is constructed in real PPP-adjusted terms. In particular, the capital goods PPP USD rate for the total economy in 2005 is sourced from the OECD STAN database; in order to obtain sectoral capital PPP rates, the sectoral GO PPP rate is multiplied by the total-economy capital goods PPP to the total-economy GO PPP ratio. For non-OECD countries the sectoral GO PPP rate is used. Capital stock data are then smoothed via a standard HP filter, as in Di Stefano and Marconi (2016).

Capital compensation data is sourced, when available, from the KLEMS databases. In the latter datasets, capital compensation is computed as the complement to one of labour compensation, under the standard assumptions of constant returns to scale and perfect competition. Since the labour compensation of self-employed is not registered in national accounts, KLEMS series are based on the standard assumption that the unit compensation of self-employed is equal to the unit compensation of employees. This assumption is made at the industry level and may be crude for some industries if earnings of self-employed and employees vary widely. It is, however, standard in the literature (Timmer et al., 2008; Gollin, 2002; Giordano and Zollino, 2021). We adopt the same assumption to compute capital compensation for the missing countries from OECD STAN data, which only provides labour compensation of employees.[44]

Despite these data-cleaning procedures, in our dataset emerging economies turn out to be more capital-intensive in some of their sectors than advanced economies, a result apparently at odds with their relative technological backwardness, yet possibly due to greater labour market informality, as discussed in Marconi and Upper (2017). To handle this issue, in our baseline computations we use country-specific (time-invariant) capital income shares for the advanced countries of our sample, whereas for emerging economies we adopt the average (time-invariant) capital compensation shares across the advanced countries. Capital income shares by sector are plotted in Figure B2. These shares are high in all industrial sectors bar construction, as well as in information and communication, and finance and insurance; they are instead lowest in construction, professional and "other" services.

Figure B2. Capital income shares by sector

(averages across advanced economies)



Source: author's estimates.

Notes: Advanced economies are those listed in Table B1 in Annex B.

[44] The capital income share happens to be negative in some cases, and is therefore dropped from the sample (as also found, for example, in Haskel, Corrado and Jona-Lasinio, 2019), similarly to the few cases in which capital income shares are larger than one (for example, for the R-S sector of the United Kingdom or the D-E and J sectors in Ireland in some years).

Table B1. Details on the country-specific variables

	Country	Main source	Secondary source	Third source	Notes	VA and employment time coverage	Capital input time coverage
1	Argentina	LA KLEMS, September 2018 release (1990-2015)	GGDC 10-Sector Database (1980-2011)			1980-2015	1993-2015
2	Australia	EU KLEMS, March 2011 release (1980-2007)	STAN Database (1980-2015)		Capital compensation data are only available for 1980-2007 in the July 2012 EU KLEMS release.	1980-2015	1980-2015
3	Austria	EU KLEMS, July 2018 release (1995-2015)	EU KLEMS, March 2011 release (1980-2007)			1980-2015	1980-2015
4	Belgium	EU KLEMS, July 2018 release (1995-2015)	EU KLEMS, March 2011 release (1980-2007)	STAN Database (1995-2015)	No capital stock data are available in the July 2018 EU KLEMS release.	1980-2015	1995-2015
5	Brazil	LA KLEMS, September 2018 release (1995-2013)	GGDC 10-Sector Database (1980-2011)		Nominal VA is only available since 1990 in the GGDC 10-Sector Database.	1980-2013	1994-2013
6	Bulgaria	EU KLEMS, July 2018 release (2000-2015)			No capital stock data are available in the July 2018 EU KLEMS release.	2000-2015	-
7	Canada	Canada KLEMS, July 2012 release (1980-2010)	STAN Database (1980-2015)		Nominal VA is available for 1980-2008 in the Canada, July 2012 release. Real and nominal value added are available for 1980-2014 in STAN Database.	1980-2014	1980-2014
8	Chile	LA KLEMS, September 2018 release (1990-2015)	GGDC 10-Sector Database (1980-2011)			1980-2015	1990-2015
9	China	China Industrial Productivity (CIP) Database 3.0 , July 2015 release (1981-2010)	GGDC 10-Sector Database (1980-2011)		Employment is available for 1980-2010 in the CIP database; nominal and real VA for 1980 is taken from GGDC 10-Sector Database.	1980-2011	1980-2010
10	Croatia	EU KLEMS, July 2018 release (2008-2015)			No capital stock data are available in the July 2018 EU KLEMS release.	2008-2015	-
11	Cyprus	EU KLEMS, July 2018 release (1995-2015)			No sectoral capital stock data are available in the July 2018 EU KLEMS release.	1995-2015	-
12	Czech Republic	EU KLEMS, July 2018 release (1995-2015)				1995-2015	1995-2015
13	Denmark	EU KLEMS, July 2018 release (1980-2015)				1980-2015	1980-2015
14	Estonia	EU KLEMS, July 2018 release (1995-2015)				1995-2015	-
15	Finland	EU KLEMS, July 2018 release (1980-2015)				1980-2015	1980-2015
16	France	EU KLEMS, July 2018 release (1980-2015)				1980-2015	1980-2015
17	Germany	EU KLEMS, July 2018 release (1995-2015)	EU KLEMS, March 2011 release (1980-2007)		Capital stock data in the March 2011 EU KLEMS release are available for 1991-2007.	1980-2015	1991-2015
18	Greece	EU KLEMS, July 2018 release (1995-2015)	EU KLEMS, March 2011 release (1980-2007)			1980-2015	1980-2015
19	Hong Kong	GGDC 10-Sector Database (1980-2011)				1980-2011	-
20	Hungary	EU KLEMS, July 2018 release (1995-2015)	EU KLEMS, March 2011 release (1992-2007)	STAN Database (1991-2015)	Capital compensation data are only available for 2010-2015 in the July 2012 EU KLEMS release. Capital stock data are only available for 1995-2015 in all datasets. Capital compensation data may be constructed from the STAN Database for 1995-2015.	1991-2015	1995-2015
21	India	India KLEMS, December 2016 release (1980-2011)	GGDC 10-Sector Database (1980-2012)			1980-2012	1980-2011
22	Indonesia	GGDC 10-Sector Database (1980-2012)				1980-2012	-
23	Iceland	STAN Database (1997-2015)			Employment and value added data for some sectors are available also prior to 1997 in the STAN Database.	1997-2015	-

Table B1. continued

	Country	Main source	Secondary source	Third source	Notes	VA and employment time coverage	Capital input time coverage
24	Ireland	EU KLEMS, July 2018 release (1995-2015)	EU KLEMS, March 2011 release (1980-2007)	STAN Database (1985-2014)	Nominal and real VA for sector H are taken from the March 2011 EU KLEMS release only, as the July 2018 release presents some inconsistencies. No sectoral capital stock data is available in the July 2018 EU KLEMS release.	1980-2015	1985-2014
25	Israel	STAN Database (1995-2015)				1995-2015	1995-2015
26	Italy	EU KLEMS, July 2018 release (1995-2015)	EU KLEMS, March 2011 release (1980-2007)			1980-2015	1980-2014
27	Japan	Japan, May 2013 release (1980-2009)	GGDC 10-Sector Database (1980-2011)	STAN Database (1980-2015)	Capital stock data are not available in the STAN Database. Capital compensation data can be constructed using the STAN database for 1980-2015.	1980-2015	1980-2009
28	Korea, Republic of	Korea, 2015 release (1980-2012)	STAN Database (1980-2015)		Capital stock data in STAN Database are available for 1980-2014, whereas capital compensation data may be derived for 1980-2015.	1980-2015	1980-2014
29	Latvia	EU KLEMS, July 2018 release (2000-2015)	STAN Database (2000-2014)		No sectoral capital stock data are available in the July 2018 EU KLEMS release.	2000-2015	2000-2014
30	Lithuania	EU KLEMS, July 2018 release (1995-2015)			Capital stock data in the July 2018 EU KLEMS release are available for 2000-2015.	1995-2015	2000-2015
31	Luxembourg	EU KLEMS, July 2018 release (1995-2015)	EU KLEMS, March 2011 release (1980-2007)		Capital stock data in the July 2018 EU KLEMS release are available for 1995-2015.	1980-2015	1995-2015
32	Malaysia	GGDC 10-Sector Database (1980-2011)				1980-2011	-
33	Malta	EU KLEMS, July 2018 release (1995-2015)	EU KLEMS, March 2011 release (1995-2007)		Only nominal VA and employment are available in the July 2018 EU KLEMS release; real VA and capital compensation are available in the March 2011 EU KLEMS release. No capital stock data are available in the July 2018 and March 2011 EU KLEMS releases.	1995-2015	1995-2007
34	Mexico	LA KLEMS, September 2018 release (1990-2015)	STAN Database (1980-2015)		Capital compensation data are constructed using the STAN Database for 1988-2015.	1980-2015	1990-2015
35	Morocco	GGDC 10-Sector Database (1980-2012)				1980-2012	-
36	Netherlands	EU KLEMS, July 2018 release (1995-2015)	EU KLEMS, March 2011 release (1980-2007)		Capital stock data in the July 2018 EU KLEMS release are available for 2000-2015.	1980-2015	1980-2015
37	New Zealand	STAN Database (1990-2015)			Capital stock data are not available in the STAN Database. Nominal and real VA are available in the STAN Database for 1980-2015; employment for some sectors is available for some years prior to 1990.	1990-2015	-
38	Norway	STAN Database (1980-2015)			Capital stock data are not available in the STAN Database.	1980-2015	-
39	Philippines	GGDC 10-Sector Database (1980-2012)				1980-2012	-
40	Poland	EU KLEMS, July 2018 release (2003-2015)	STAN Database (1994-2015)		Capital stock data are available in the STAN Database for 2000-2015. Capital data compensation is constructed using the STAN Database for 2000-2014.	1994-2015	2000-2014
41	Portugal	EU KLEMS, July 2018 release (1995-2015)	EU KLEMS, March 2011 release (1980-2007)	STAN Database (2000-2014)	No sectoral capital stock data are available in the July 2018 EU KLEMS release. Capital stock data are available in the STAN Database for some sectors.	1980-2015	2000-2014

Table B1. continued

	Country	Main source	Secondary source	Third source	Notes	VA and employment time coverage	Capital input time coverage
42	Romania	EU KLEMS, July 2018 release (1995-2015)			No capital stock data are available in the July 2018 EU KLEMS release.	1995-2015	-
43	Russian Federation	Russia, March 2017 release (1995-2014)				1995-2014	-
44	Singapore	GGDC 10-Sector Database (1980-2011)				1980-2011	-
45	Slovakia	EU KLEMS, July 2018 release (1995-2015)			Capital stock data in the July 2018 EU KLEMS release are available for 2004-2015.	1995-2015	2004-2015
46	Slovenia	EU KLEMS, July 2018 release (1995-2015)	EU KLEMS, March 2011 release (1995-2007)		Capital stock data in the July 2018 EU KLEMS release are available for 2000-2015. Capital stock data in the March 2011 EU KLEMS release are available for 1995-2007.	1995-2015	1995-2015
47	South Africa	GGDC 10-Sector Database (1980-2011)				1980-2011	-
48	Spain	EU KLEMS, July 2018 release (1995-2015)	EU KLEMS, March 2011 release (1980-2007)			1980-2015	1980-2015
49	Sweden	EU KLEMS, July 2018 release (1993-2015)	EU KLEMS, March 2011 release (1980-2007)		Capital stock data in the July 2018 EU KLEMS release are available for 1993-2014.	1980-2015	1993-2014
50	Switzerland	STAN Database (1990-2015)			Capital stock data are not available in the STAN Database.	1990-2015	-
51	Thailand	GGDC 10-Sector Database (1980-2011)				1980-2011	-
52	Turkey	STAN Database (2004-2015)			Nominal and real VA are available for 1998-2015 in the STAN Database. Capital stock data are not available in the STAN Database.	2004-2015	-
53	United Kingdom	EU KLEMS, July 2018 release (1995-2015)	UK, 2012 EU KLEMS release (1980-2010)	GGDC 10-Sector Database (1980-2011)	Employment is available for some sectors for 1980-2015 in the July 2018 EU KLEMS release; the 2012 EU KLEMS release covers nominal and real VA and capital compensation for 1980-1995, whereas the GGDC 10-Sector Database covers employment for 1980-1995 in some sectors. Capital stock data in the July 2018 EU KLEMS release are available for 1997-2015.	1980-2015	1980-2015
54	United States	EU KLEMS, July 2018 release (1980-2015)	US, April 2013 release (1980-2010)		Employment is available for 2000-2015 and capital compensation for 1987-2015 in the July 2018 EU KLEMS release; the US April 2013 release fills these gaps.	1980-2015	1980-2015

Table B2. Capital income shares by sector in advanced economies

(1980-2015 averages)

Sector code	Sector	Average of advanced economies	US
A	Agriculture, forestry and fishing	0.37	0.53
B	Mining and quarrying	0.58	0.67
C	Manufacturing	0.37	0.42
D-E	Electricity, gas and water supply	0.65	0.73
F	Construction	0.26	0.16
G	Wholesale and retail trade; repair of motor vehicles and motor cycles	0.32	0.42
H	Transportation and storage	0.34	0.27
I	Accommodation and food storage activities	0.28	0.34
J	Information and communication	0.45	0.50
K	Financial and insurance activities	0.41	0.41
M-N	Professional, scientific, technical, administrative and support service activities	0.29	0.19
R-S	Arts, entertainment, recreation and other service activities	0.25	0.24

Source: author's estimates.

Notes: See the main text for the computation methodology. Advanced economies are those listed in Table A1.

Annex C. The theoretical models underlying the inter-sectoral production factor misallocation measures

C1. Ando and Nassar's (2017) model

The single-period frictionless general equilibrium model in Ando and Nassar (2017) is a multi-sector extension of the model of occupational choice under risk in Kanbur (1979) in which sectoral productivity is equalized among all the S sectors of the economy, an outcome which in turn is compatible with the decreasing returns to scale production technology in individual heterogeneous firms.

In the model each agent i can choose which sector to enter and which of two occupations to undertake, either as an entrepreneur or as a worker. If agent i enters sector s as a worker, she supplies a unit of labour of uniform quality and she earns the competitive wage w_s. Otherwise, she can enter the activity of managing a firm for profit by hiring labour at a guaranteed wage while bearing an (unknown *ex ante*) "entrepreneurial ability risk". In particular, she draws a lottery on the productivity of her firm $z_{si} \sim G_s$ and then determines the number h_{si} of her employees, by solving the following maximization problem:

(C1) $[\pi_{si}, h_{si}] = \max_{h} p_s\, z_{si} h^{\alpha_s} - w_s h$

where π_{si} are the profits of firm i (and the income of entrepreneur i), α_s is the share of sales paid to employees and w_s is the income of employees. Note that, although the model does not have capital as in the standard neoclassical setting, the presence of entrepreneurs may be interpreted such that the owner of each firm owns one unit of firm-specific capital, so that the profit is the return on capital.

Given individual income e_i, each agent maximizes her utility:

(C2) $[v(p, e_i), c_i]= \max_{c_s} \prod_{s=1}^{S} c_s^{\gamma_s}$

s.t. $\sum_{s=1}^{S} p_s c_s = e_i$

where v and $c_i = \{c_{is}\}_s$ are the indirect utility function and the consumption, respectively, and the preference parameter γ_s represents the expenditure share of product s, in that $\sum_{s=1}^{S} \gamma_s = 1$. Note that the indirect utility function v is linear in income e, implying that agents are risk-neutral with respect to income.

Since all agents choose their occupations, income has to satisfy the free entry condition:

(C3) $E[v(p, \pi_s)]= v(p, w_s) = v(p, w_{s'})\ \forall s, s'$

where expectations is with respect to $z_s \sim G_s$ for each sector s.

Finally, the set of prices (p_s, w_s), the number of people engaged in sector n_s and the fraction of entrepreneurs among them ϕ_s are consistent with the following market-clearing conditions:

(C4) $\int h_{si}\, d_i = (1-\phi_s)\, n_s$;

(C5) $\sum_{s=1}^{S} n_s$=1 (i.e. population size is normalised to unity):

(C6) $Y_s = \int y_{si} di = \int c_{si} di$.

This general equilibrium model has a closed form solution. The firm's problem (C1) can indeed be solved as follows:

(C7) $h_{si} = (\frac{p_s z_{si} \alpha_s}{w_s})^{\frac{1}{1-\alpha_s}}$ and

(C8) $\pi_{si} = p_s(1-\alpha_s){\alpha_s}^{\frac{\alpha_s}{1-\alpha_s}} {z_{si}}^{\frac{1}{1-\alpha_s}} (\frac{w_s}{p_s})^{-\frac{\alpha_s}{1-\alpha_s}}$.

The free entry condition (C3) implies:

(C9) $\frac{w_s}{p_s} = (1-\alpha_s)^{(1-\alpha_s)} {\alpha_s}^{\alpha_s} \, (E z_s^{\frac{1}{1-\alpha_s}})^{1-\alpha_s}$ and

(C10) $\varphi_s = (1-\alpha_s)$.

The production function can be aggregated into:

(C11) $Y_s = (E z_s^{\frac{1}{1-\alpha_s}})^{1-\alpha_s} (1-\alpha_s)^{(1-\alpha_s)} {\alpha_s}^{\alpha_s}\, n_s$

so that the consumer's problem and the market-clearing conditions imply:

(C12) $\gamma_s \frac{\sum_{s=1}^{S} p_s Y_s}{p_s} = Y_s \; \forall s \Rightarrow \frac{p_s}{p_{s'}} = \frac{y_s}{y_{s'}}$ and $n_s = y_s$.

Hence, the equilibrium exists and is unique.

An important implication of the model is that productivity is equalised across sectors in equilibrium. Indeed, by observing that total sales are distributed to both entrepreneurs and workers, the following expression can be derived:

(C13) $n_s \phi_s \mathrm{E}\pi_s + n_s(1-\phi_s) w_s = p_s Y_s$.

Since entrepreneurs and workers are indifferent due to the free entry condition:

(C14) $\mathrm{E}\pi_s = w_s$

and free entry also equalises all sectors' wages:

(C15) $w_s = w_{s'} \; \forall s, s'$.

Therefore, sectoral productivity is the same across all sectors:

(C16) $\frac{p_s Y}{n_s} = \frac{p_{s'} Y_{s'}}{n_{s'}} \; \forall s, s'$.

C2. Aoki's (2012) model

According to Aoki's (2012) multi-sector model, price-taker firms in each sector produce intermediate goods at sector price p_i with two production factors, capital and labour, on which sector-specific linear taxes are paid, such that capital and labour costs are $(1+\tau_{K,i})p_k$ and $(1+\tau_{L,i})p_l$, respectively. In the absence of taxes, because capital and labour are homogeneous across sectors, factor costs would equalize. Since each sector produces different intermediate goods, the goods price p_i can vary across sectors in equilibrium, even if there are no taxes.

As the firm's production function is assumed to reflect constant returns to scale (CRS), each sector can be identified by a representative firm. In particular, the production function of firm i, which is price-taker in both the production factors and goods markets, is given by a Cobb-Douglas function:

(C17) $Y_i = A_i K_i^{\alpha_i} L_i^{1-\alpha_i}$

where Y_i, L_i and K_i are, respectively, VA and the labour and capital inputs and α_i denotes the share of capital income. Capital and labour income shares are allowed to differ across sectors and sum to one under CRS. Firms also differ in terms of their productivity level A_i.

The standard profit maximization problem of the firm is the following:

(C18) $\max_{K_i,L_i} p_i\, A_i K_i^{\alpha_i} L_i^{1-\alpha_i}$- $(1+\tau_{K,i})p_K K_i$ -$(1+\tau_{L,i})p_L L_i$

which yields the first-order conditions (FOCs) as follows:

(C19a) $\frac{\alpha_i p_i Y}{K_i} = (1+\tau_{K,i})p_K$

(C19b) $\frac{(1-\alpha_i)p_i Y_i}{L_i} = (1+\tau_{L,i})p_L$

Assuming a CSR aggregator function and an economy in perfect competition and normalizing the final good price to unity:

(C20) $Y = \sum_i p_i Y_i$.[45]

[45] Aoki (2012) does not specify the form of the final good production function. However, the model implicitly assumes that sector shares do not respond to changes in frictions, which is equivalent to the special case of unitary elasticity of substitution between intermediate goods.

There is no capital depreciation or investment, and therefore output equals consumption.

Finally, assuming that aggregate supply of capital and labour are exogenous, the following market-clearing conditions apply:

(C21) $K = \sum_i K_i$

(C22) $L = \sum_i L_i$

By combining the FOC for capital (eq. C19a) and the capital resource constraint (eq. C22), K_i can be rewritten as:

$$\text{(C23)}\ K_i = \frac{\frac{(1+\tau_{K,i})p_K K_i}{(1+\tau_{K,i})p_K}}{\sum_j \frac{(1+\tau_{K,j})p_K K_j}{(1+\tau_{K,j})p_K}} K = \frac{\alpha_i p_i Y_i \frac{1}{(1+\tau_{K,i})p_K}}{\sum_j \alpha_j p_j Y_j \frac{1}{(1+\tau_{K,j})p_K}} K = \frac{\alpha_i \sigma_i \frac{1}{(1+\tau_{K,i})}}{\sum_j \alpha_j \sigma_j \frac{1}{(1+\tau_{K,j})}} K$$

where σ_i is the nominal sectoral VA share: $\sigma_i \equiv \frac{p_i Y_i}{Y}$. Moreover, by defining the VA-weighted average of capital income shares as $\alpha \equiv \sum_i \sigma_i \alpha_i$ and $\lambda_{K,i} \equiv \frac{\frac{1}{(1+\tau_{K,i})}}{\sum_j \frac{\sigma_j \alpha_j}{\alpha(1+\tau_{K,j})}}$, the equilibrium allocation of capital, K_i, can be rewritten as:

(C24) $K_i = \frac{\alpha_i \sigma_i}{\alpha} \lambda_{K,i} K$

Similarly, the equilibrium allocation of labour L_i can be expressed as:

(C25) $L_i = \frac{\sigma_i (1-\alpha_i)}{(1-\alpha)} \lambda_{L,i} L$, where $\lambda_{L,i} \equiv \frac{\frac{1}{(1+\tau_{L,i})}}{\sum_j \frac{\sigma_j (1-\alpha_j)}{(1-\alpha)(1+\tau_{L,j})}}$.

Frictions mainly affect the allocation of resources through $\lambda_{K,i}$ and $\lambda_{L,i}$, although they can also affect σ_i. Rearranging, capital and labour frictions can therefore be measured as, respectively:

(C26) $\lambda_{K,i} = (\frac{\sigma_i \alpha_i}{\alpha})^{-1} \frac{K_i}{K}$ and

(C27) $\lambda_{L,i} = (\frac{\sigma_i (1-\alpha_i)}{(1-\alpha)})^{-1} \frac{L_i}{L}$.

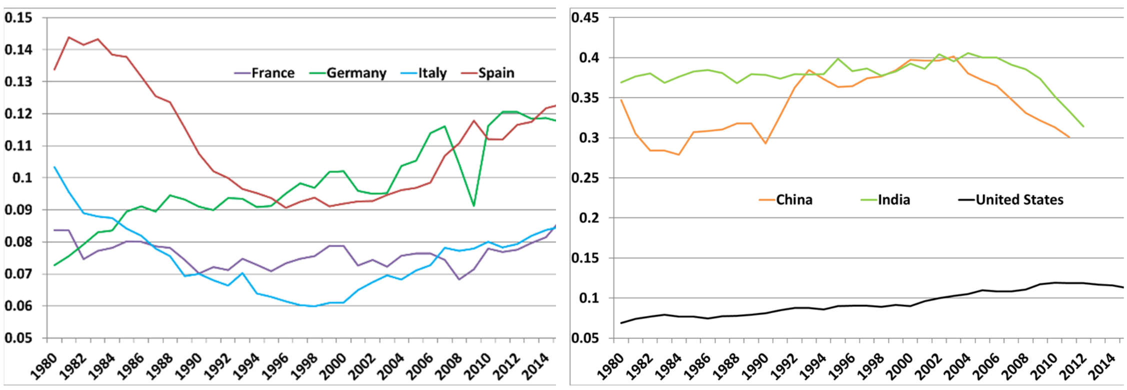
Note that if, for example, $\tau_{K,i} = \tau_{K,j} = \tau_K$, then $\lambda_{K,i} = 1$, which is the case of a frictionless economy. Suppose instead that $\tau_{K,i} < \tau_{K,j}$, then $\lambda_{K,i} > 1$ and $\lambda_{K,j} < 1$: since capital is relatively less expensive in sector *i* then it is over-allocated to this sector and under-allocated in all other sectors.

Annex D. Additional tables and charts on inter-sectoral production factor misallocation

Figure D1 focuses on annual SDI dynamics in the four main euro-area countries, in the United States, and in China and India. The patterns of labour misallocation of the advanced economies are consistent with that of structural transformation (i.e. a U-shape pattern of misallocation, with the United States and Germany having begun their structural change at an earlier stage than the other euro-area economies),[46] whereas in the case of China and India the significant positive effects of rural labour shedding have appeared only in the latest decade, consistently with studies focusing on these economies (e.g. Di Stefano and Marconi, 2016).

Figure D1. The total-economy SDI in selected countries: time series

Main euro-area countries **China, India and the United States**



Source: author's estimates.
Notes: The SDI is based on nominal VA shares. A rise in the SDI entails a rise in labour misallocation.

Table D1 and Figure D2 confirm how the SDI findings in Section 4.2, computed on nominal VA shares, are generally robust to the use of the corresponding real 2005 PPP-adjusted shares. Dynamics, if anything, are more pronounced in the latter case.

Table D2 instead reports the level of the SDI for a wider number of countries in 2009, based on both nominal and real VA shares, replicating the same economies and year for which Ando and Nassar (2017, p. 18) publish their estimates. Relative to the smaller subset of countries commented in Table 3, in this larger sample it is even more evident that labour misallocation is highest in emerging economies and lowest in euro and non-euro area advanced economies. For 2009 our levels and ranking of countries are

[46] Our findings for the four main euro-area countries are consistent with those in Grjebine, Héricourt and Tripier (2019), which points to an increasing TFP loss due to inefficient inter-sectoral labour allocation in the 2000s (in France in particular after the GFC).

somewhat different to those in Ando and Nassar (2017), due to the heterogeneous data sources employed, yet the unfavourable ranking of emerging economies is confirmed.[47]

Zooming in on the five advanced economies' sectoral SDIs (Fig. D3), we find that the stylised fact of large and decreasing excess labour in agriculture is clear mainly for France, Italy and Spain. In Germany over-employment was highest, and broadly stable over time, in the retail and wholesale trade sector, which was also characterised by vast excess labour in the other three euro-area countries and in the United States by the end of the 1980-2015 period. Amongst the industrial sectors, whereas manufacturing in the advanced economies followed the common trend of passing from a negligible structural distortion to significant under-employment – currently particularly strong in Germany –, construction generally recorded over-employment (in the case of Spain, only until the GFC, after which a correction ensued). Finally, in recent years in the advanced economies professional services, but also hotels and restaurants and "other services", marked an expansion in excess labour, thereby largely contributing to total-economy labour misallocation, similarly to information and communication activities, finance and insurance, and utilities, which, according to the country, were particularly undersized in 2015. Finally, China and India stand out as displaying massive over-employment in agriculture, the main driver of their total-economy misallocation, which decreased only in recent years. Moreover, China is an outlier due to its broad under-employment in manufacturing, especially in the 1990s, which only started to correct as of the early 2000s, but which in 2015 was still vast.

Table D3 compares the sector-specific 1980-2015 average capital income shares for the set of advanced economies with those of the US (in turn very similar to those reported in Acemoglu and Guerrieri (2008), referring to the 1948-2004 period, and hence confirming the fact that time variation in capital shares is less relevant than their sectoral variation). Significant differences appear concerning agriculture and distribution, which

[47] In particular, Ando and Nassar (2017) employ the 10-sector GGDC Productivity Database, based on the old ISIC rev. 3.1 code, as opposed to our multiple, and more updated, sources described in Section 4.1. Moreover, they include government services in their total-economy indicator, which we instead exclude. The higher misallocation found for emerging economies may be due to greater measurement error in their underlying data. Although we cannot exclude this possibility, the fact that our results are comparable to those in Ando and Nassar (2017) based on a different database and the fact that our findings are confirmed even when using another proxy for labour misallocation in Section 4.4 are both encouraging signals. Furthermore, this result is quite standard in the structural change literature based on productivity decompositions (e.g. McMillan and Rodrik, 2011). Finally, Bils, Klenow and Ruane (2020) attempts to correct (intra-industry) misallocation for measurement error and still finds a significant presence of allocative inefficiency in the U.S. and, to a much higher extent, India, as found in our study.

are 16 and 10 percentage points more capital-intensive in the US than on average in advanced economies, and construction, which is 10 points less capital-intensive.

Table D1. The total-economy SDI in selected countries based on real VA shares: levels and ranking

	1980-1992		1993-2007		2008-2015	
Country:	SDI	*Country ranking*	SDI	*Country ranking*	SDI	*Country ranking*
France	0.08	1	0.07	2	0.12	2
United States	0.09	2	0.11	4	0.16	5
Italy	0.10	3	0.07	1	0.11	1
United Kingdom	0.10	4	0.12	5	0.14	4
Germany	0.11	5	0.13	6	0.17	6
Netherlands	0.13	6	0.16	7	0.18	8
Spain	0.13	7	0.10	3	0.12	3
China	0.31	8	0.39	9	0.33	9
India	0.41	9	0.44	10	0.41	10
Brasil	-	-	0.23	8	0.17	7

Source: author's estimates.

Notes: The total-economy SDI is based on real 2005 PPP USD-adjusted VA shares. Averages may be taken on shorter sub-periods than those displayed herein for some countries, according to the data availability reported in Table C1 in Annex C. Figures highlighted in green (red) refer to the three most (least) "efficient" countries amongst the ten countries listed. A rise in the SDI entails a reduction in allocative efficiency.

Table D2. The total-economy SDI in 2009 in selected countries: levels and ranking

	Ando and Nassar (2017) (nominal VA)		Author's estimates (nominal VA)		Author's estimates (real VA in 2005 PPP terms)	
Country	SDI	*Country ranking*	SDI	*Country ranking*	SDI	*Country ranking*
Netherlands	0.09	1	0.13	10	0.18	14
Japan	0.09	2	0.11	6	0.16	9
Spain	0.09	3	0.12	9	0.11	4
Denmark	0.10	4	0.10	5	0.15	7
France	0.10	5	0.07	1	0.10	2
Singapore	0.11	6	0.10	4	0.12	5
Sweden	0.12	7	0.08	3	0.14	6
Hong Kong	0.14	8	0.12	9	0.11	3
United Kingdom	0.14	9	0.13	11	0.15	8
Italy	0.17	10	0.08	2	0.10	1
South Africa	0.18	11	0.21	16	0.21	17
Mexico	0.18	12	0.17	13	0.17	11
Malaysia	0.19	13	0.19	14	0.19	15
Chile	0.20	14	0.25	18	0.20	16
Brazil	0.20	15	0.20	15	0.18	12
Korea	0.20	16	0.23	17	0.25	18
Argentina	0.22	17	0.17	12	0.17	13
United States	0.22	18	0.12	7	0.16	10
Philippines	0.29	19	0.30	19	0.32	19
Indonesia	0.33	20	0.34	21	0.32	20
China	0.36	21	0.32	20	0.34	21
Thailand	0.38	22	0.40	23	0.40	22
India	0.41	23	0.37	22	0.43	23
Germany	-	-	0.09	(4)	0.10	(2)

Source: author's estimates and Ando and Nassar (2017).

Notes: Figures highlighted in green (red) refer to the five most (least) "efficient countries" amongst the countries listed; Germany's ranking figure is in brackets as it is the ranking that Germany would have had, had it been included in the sample of countries. An increase in the SDI entails a rise in labour misallocation.

Table D3. Correlations between the SDI and the dispersion in labour frictions

5-year average levels

	Correlation
Whole sample	0.85
Advanced economies	0.56
Emerging economies	0.94
Pre-1999	0.83
Post-1999	0.92

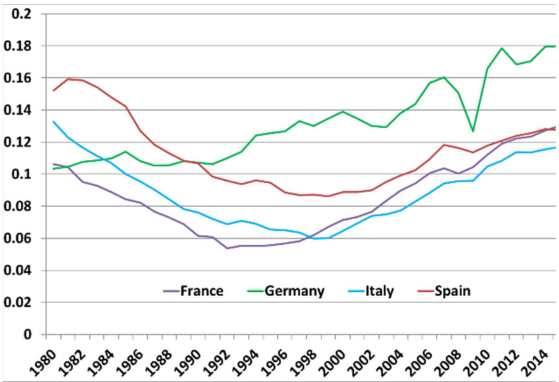
5-year annual average growth rates

	Correlation
Whole sample	0.74
Advanced economies	0.69
Emerging economies	0.91
Pre-1999	0.74
Post-1999	0.75

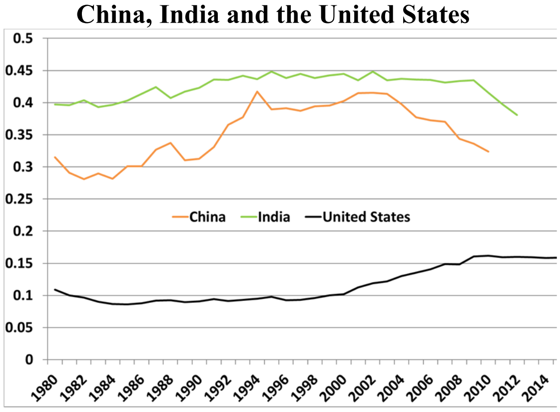
Source: author's estimates.
Notes: The total-economy SDI is based on nominal VA shares. Total-economy dispersion in labour frictions is computed as the weighted Gini index of sector-level labour frictions, where the weights are nominal VA shares and average capital income shares, as described in the main text.

Figure D2. The total-economy SDI in selected countries based on real VA shares: time series

Main euro-area countries



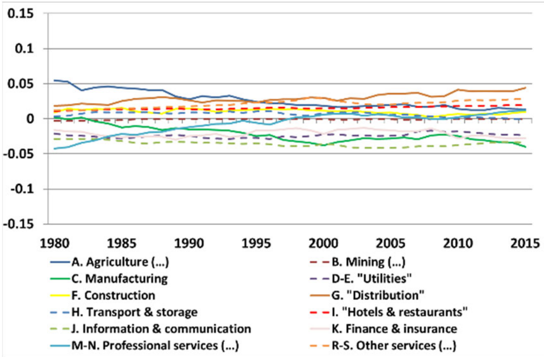
China, India and the United States



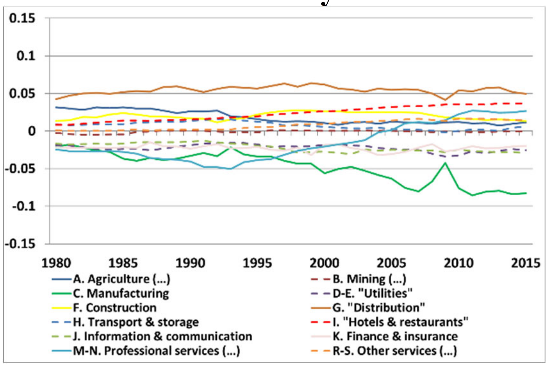
Source: author's estimates.
Notes: The total-economy SDI is based on real 2005 PPP USD-adjusted VA shares. A rise in the SDI entails an increase in labour misallocation.

Figure D3. Sectoral SDIs in selected countries

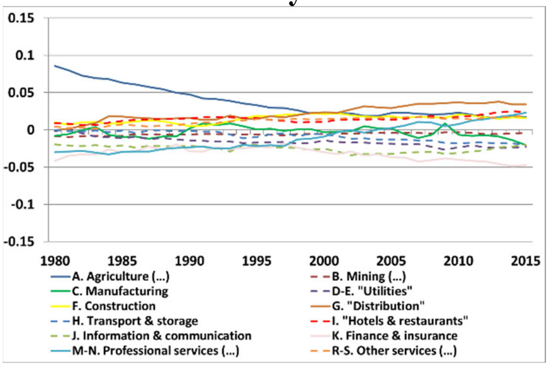
France



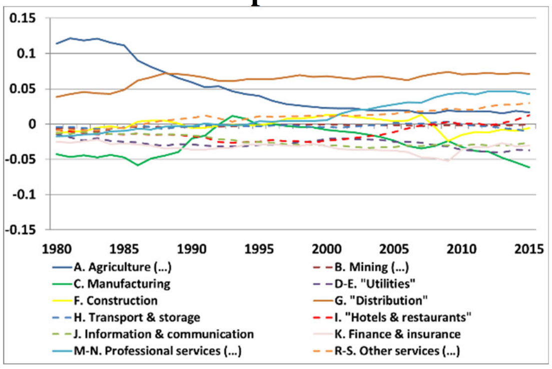
Germany



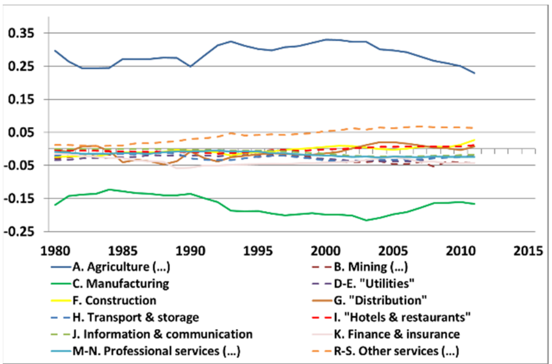
Italy



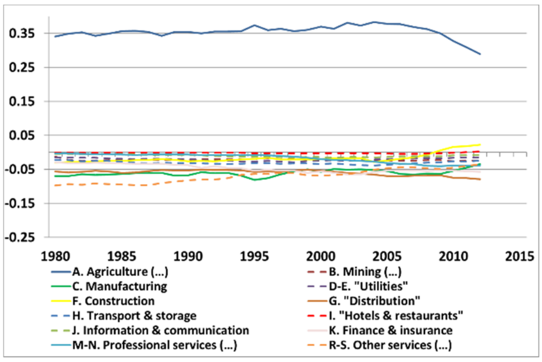
Spain



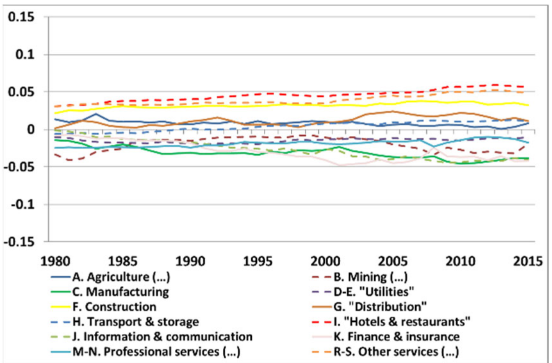
China



India



United States



Source: author's estimates.

Notes: The sectoral SDIs are based on nominal VA shares. Negative (positive) values of the index imply under-employment (over-employment) in a given sector; misallocation is null when the indicator is zero. A rise in misallocation is signalled either by a decrease of a negative value or by an increase of a positive value.

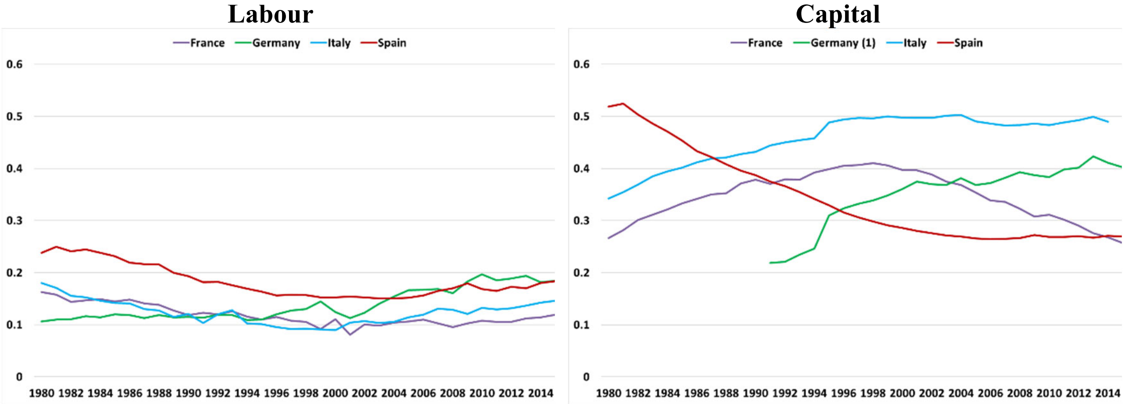
As regards dynamics, in the overall 1980-2015 period labour misallocation followed a U-shape pattern in the advanced economies under study bar Germany and the United States, where it gradually rose over time (Fig. D4). In the two emerging economies labour frictions followed an inverted U-shape, beginning to decline at the start of the new millennium, and confirming similar patterns in Di Stefano and Marconi (2016). Capital frictions, on the other hand, recorded different dynamics to labour distortions in all seven countries, and independently from the stage of economic development. Capital misallocation indeed significantly increased over time in Italy, Germany, China and, to a lesser extent due to the higher initial level, in India. Conversely, capital frictions declined in Spain, until the early 2000s, linked in part to the fact that the real capital stock share in construction significantly fell as of the 1980s (plausibly due to an increasing weight of non-residential capital as the economy developed), only slightly picking up in the run-up to the GFC, yet not enough to reverse the long-run trend. Capital misallocation also decreased in the United States, albeit starting from very high levels in the 1980s, possibly reflecting the prevalence of tight financial market regulation which was loosened only over that decade (Niskanen, 1989; Marconi and Upper, 2017).

Figure D4. Total-economy dispersion in production factor frictions: dynamics

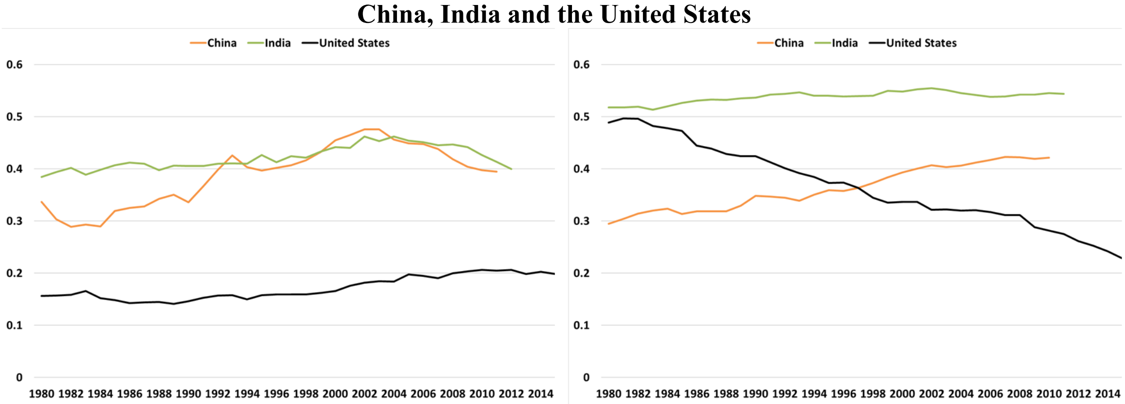
(Gini coefficient, weighted with nominal VA shares)

Main euro-area countries

Labour | **Capital**



China, India and the United States



Source: author's estimates.

Notes: Total-economy labour (capital) misallocation is computed as the weighted Gini index of sector-level labour (capital) frictions, where the weights are nominal VA shares and average capital income shares. An increase in the dispersion in capital (labour) frictions across sectors entails a rise in total-economy capital (labour) misallocation. (1) Capital stock data for Germany are only available since 1991.

Annex E. Regression robustness tables

The empirical growth literature has identified more than 145 growth determinants, although there is no consensus on which of these variables should be included in growth models (Durlauf, Johnson and Temple, 2005). With respect to most standard growth regressions, our model includes country fixed effects; therefore many of these additional explanatory variables would be collinear with these dummies. Indeed, in equation 9, reported in Section 5.1, as a preliminary step, we also included the average years of education (a common proxy of human capital), the CPI inflation rate (a standard measure of lack of macroeconomic stability) and the government effectiveness indicator (a proxy of institutional quality, available since 1996), all sourced from the World Bank's World Development and World Governance Indicators datsets and from the IMF WEO database. None of these variables were statistically significant and were hence excluded from the baseline regression. In Table E1 we however show that, by moving to a cross-sectional setup (in which all variables are averaged over the whole available time-span and in which fixed effects are dropped, as in Rodrik 2008), these additional growth control variables turn statistically significant, displaying their expected signs, without in any way altering the findings concerning the main variable of interest (i.e. the REER misalignment).

Table E1. REER misalignments and economic growth: cross-sectional results with additional growth variables

(dependent variable: average annual GDP per capita growth over a 5-year period)

	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)
Initial real GDP per capita (ln)	-0.009***	-0.009***	-0.012***	-0.013***	-0.009***	-0.009***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Absolute REER misalignment (35-yr mean; pctge. pts.)	-0.016***		-0.004		-0.013***	
	(0.003)		(0.003)		(0.003)	
Positive REER misalignment (35-yr mean; pctge. pts.)		-0.022***		-0.024***		-0.020**
		(0.008)		(0.007)		(0.008)
Negative REER misalignment (35-yr mean; pctge. pts.)		0.017***		0.005		0.014***
		(0.004)		(0.003)		(0.004)
Gross domestic savings rate (35-yr mean; in pctge. of GDP)	0.072***	0.071***	0.063***	0.062***	0.067***	0.066***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.007)
Government effectiveness (35-yr mean)			0.006***	0.006***		
			(0.001)	(0.001)		
Inflation rate (35-yr mean; pctge. pts.)					-0.008***	-0.009***
					(0.003)	(0.003)
Constant	0.103***	0.105***	0.132***	0.137***	0.104***	0.107***
	(0.008)	(0.009)	(0.009)	(0.010)	(0.008)	(0.009)
Adjusted R-squared	0.486	0.481	0.525	0.532	0.492	0.491
Number of observations	57	57	57	57	57	57

Notes: Robust standard errors are reported in brackets. ***, ** and * denote statistical significance levels at 1, 5 and 10%, respectively.

Moreover, as discussed in Berg and Miao (2010), the variables typically employed in a BEER model cannot plausibly be excluded from a growth regression *ex ante*, since any variable that effects growth may do so differentially across traded and non-traded sectors, and thus would matter for the REER. Hence, as a further preliminary step, we included the REER determinants of the BEER model described in Section 3 in equation 9 without the REER misalignment term, so as to check their possible direct effect on growth.[48] According to results available upon request, we find that amongst our BEER model variables – which we recall are GDP per capita, terms of trade, trade costs, the OAD ratio and government consumption – only initial GDP per capita and the five-year-average investment rate are statistically significant at conventional confidence levels. Having already included the savings rate in equation 9, we do not also include the investment rate, given the high collinearity between the two variables.

In Table E2 we use a financial development index, sourced from the IMF, in lieu of the savings rate in the spirit of the uphill capital flow literature. It is not significant and baseline results concerning the variables of interest are confirmed.

Table E2. REER misalignments and economic growth: financial development in lieu of the savings rate

(dependent variable: average annual GDP per capita growth over a 5-year period)

	(1a) OLS	(1b) SGMM	(2a) OLS	(2b) SGMM
Initial real GDP per capita (ln)	-0.040***	-0.018***	-0.040***	-0.016***
	(0.009)	(0.003)	(0.009)	(0.004)
Absolute REER misalignment (5-yr mean; pctge. pts.)	-0.045***	-0.048***		
	(0.011)	(0.006)		
Positive REER misalignment (5-yr mean; pctge. pts.)			-0.062***	-0.079***
			(0.011)	(0.017)
Negative REER misalignment (5-yr mean; pctge. pts.)			0.040***	0.049***
			(0.013)	(0.010)
Financial development (5-yr mean; pctge. pts.)	0.018	-0.007	0.018	-0.004
	(0.022)	(0.015)	(0.020)	(0.011)
Adjusted R-squared	0.672		0.670	
Number of observations/number of countries	389/54	389/55	389/56	389/57
Number of instruments		68		88
Arellano and Bond test for AR(2) in first-differences		0.128		0.311
Hansen test of over-identifying restrictions		0.669		0.985

Notes: Country and time (Time) fixed effects are included in the OLS specifications (SGMM specifications), but here not reported. In the SGMM estimations all variables are treated as endogenous, except for the time dummies. To avoid excessive instrument proliferation, the lags of the instrumented variables are truncated at one in first differences and at two in levels in all specifications. Robust clustered standard errors are reported for OLS in brackets; in the case of two-step SGMM the errors are also subject to Windmeijer's (2005) correction. ***, ** and * denote statistical significance levels at 1, 5 and 10%, respectively. For the two tests, p-values are reported, when applicable.

[48] We include these variables in absolute terms for each country, and not *vis-à-vis* (the weighted average of) trading partners (as they appear in the BEER model), and as initial or five-year averages (differently to the annual data of the BEER model).

In Table E3 PPP-based REER misalignments are shown to outperform alternatively deflated misalignment measures when they are all jointly included in equation 9.

Table E3. A horse-race amongst alternatively deflated REER measures in the assessment of the REER misalignment and economic growth relationship

(dependent variable: average annual GDP per capita growth in 5-year periods)

	(1a) OLS	(1b) SGMM	(2a) OLS	(2b) SGMM	(3a) OLS	(3b) SGMM	(4a) OLS	(4b) SGMM
Initial real GDP per capita (ln)	-0.055***	-0.015***	-0.049***	-0.014***	-0.049***	-0.017***	-0.046***	-0.011***
	(0.011)	(0.003)	(0.012)	(0.004)	(0.012)	(0.003)	(0.011)	(0.003)
Absolute PPP-based REER misalignment (5-yr mean; pctge. pts.)	-0.051***	-0.030***	-0.049***	-0.034***	-0.050***	-0.040***		
	(0.011)	(0.008)	(0.010)	(0.007)	(0.011)	(0.007)		
Absolute CPI-based REER misalignment (5-yr mean; pctge. pts.)	-0.016	-0.026*	-0.016	-0.021				
	(0.010)	(0.015)	(0.010)	(0.016)				
Absolute GDP deflator-based REER misalignment (5-yr mean; pctge. pts.)	0.022*	0.02	0.022*	0.021	0.008*	-0.001	-0.002	-0.005
	(0.012)	(0.015)	(0.012)	(0.016)	(0.004)	(0.002)	(0.005)	(0.003)
Absolute PP1-based REER misalignment (5-yr mean; pctge. pts.)	0.004	0.004						
	(0.003)	(0.004)						
Gross domestic savings rate (5-yr mean; in pctge. of GDP)	0.114***	0.099***	0.091***	0.095***	0.090***	0.081**	0.107***	0.109***
	(0.026)	(0.030)	(0.027)	(0.032)	(0.027)	(0.032)	(0.028)	(0.029)
Adjusted R-squared	0.714		0.71		0.709		0.656	
Number of observations/number of countries	383/52	383/52	402/54	402/54	402/54	402/54	402/54	402/54

Notes: Country and time (Time) fixed effects are included in the OLS specifications (SGMM specifications), but here not reported. In the SGMM estimations all variables are treated as endogenous, except for the time dummies. To avoid excessive instrument proliferation, the lags of the instrumented variables are truncated at one in first differences and at two in levels in all specifications. Robust clustered standard errors are reported for OLS in brackets; in the case of two-step SGMM the errors are also subject to Windmeijer's (2005) correction. ***, ** and * denote statistical significance levels at 1, 5 and 10%, respectively. For the two tests, p-values are reported, when applicable.

We next consider all explanatory variables, including REER misalignments, at the beginning of each period (in the vein, for example, of Béreau, López Villavicencio and Mignon, 2012), instead of at their five-year averages (Table E4). Baseline results are confirmed, with the exception of REER undervaluations turning statistically insignificant. This may be due to the fact that, relative to overvaluations, undervaluations are larger and more volatile; hence capturing the latter only in one year may be misleading. Moreover, the fit of the specifications slightly deteriorates.

Next, we investigate the stability of our main coefficients of interest once the savings rate is dropped (we continue to retain the initial GDP level, given the documented role of economic convergence). These results, reported in Table E5, confirm our main findings, although the fit of the specification marginally worsens, confirming the importance of the inclusion of this variable.

Table E4. REER misalignments and economic growth: considering all explanatory variables in the initial year of 5-year periods

(dependent variable: average annual GDP per capita growth in 5-year periods)

	(1a)	(1b)	(2a)	(2b)
	OLS	SGMM	OLS	SGMM
Initial real GDP per capita (ln)	-0.043***	-0.014***	-0.045***	-0.012***
	(0.012)	(0.003)	(0.011)	(0.003)
Initial absolute REER misalignment (pctge. pts.)	-0.006	-0.013*		
	(0.006)	(0.007)		
Initial positive REER misalignment (pctge. pts.)			-0.037***	-0.034***
			(0.009)	(0.011)
Initial negative REER misalignment (pctge. pts.)			-0.002	0.005
			(0.006)	(0.010)
Initial gross domestic savings rate (in pctge. of GDP)	0.053*	0.082**	0.058**	0.075*
	(0.030)	(0.036)	(0.027)	(0.039)
Adjusted R-squared	0.641		0.662	
Number of observations/number of countries	401/54	401/54	401/54	401/54
Number of instruments		68		88
Arellano and Bond test for AR(2) in first-differences		0.052		0.121
Hansen test of over-identifying restrictions		0.728		0.993

Notes: Country and time (Time) fixed effects are included in the OLS specifications (SGMM specifications), but here not reported. In the SGMM estimations all variables are treated as endogenous, except for the time dummies. To avoid excessive instrument proliferation, the lags of the instrumented variables are truncated at one in first differences and at two in levels in all specifications. Robust clustered standard errors are reported for OLS in brackets; in the case of two-step SGMM the errors are also subject to Windmeijer's (2005) correction. ***, ** and * denote statistical significance levels at 1, 5 and 10%, respectively. For the two tests, p-values are reported, when applicable.

Table E5. REER misalignments and economic growth: dropping the savings rate

(dependent variable: average annual GDP per capita growth in 5-year periods)

	(1a)	(1b)	(2a)	(2b)
	OLS	SGMM	OLS	SGMM
Initial real GDP per capita (ln)	-0.040***	-0.018***	-0.040***	-0.016***
	(0.010)	(0.003)	(0.009)	(0.004)
Absolute REER misalignment (5-yr mean; pctge. pts.)	-0.042***	-0.046***		
	(0.011)	(0.006)		
Positive REER misalignment (5-yr mean; pctge. pts.)			-0.061***	-0.083***
			(0.011)	(0.015)
Negative REER misalignment (5-yr mean; pctge. pts.)			0.037***	0.048***
			(0.013)	(0.009)
Adjusted R-squared	0.669		0.669	
Number of observations/number of countries	409/54	409/54	409/54	409/54
Number of instruments		68		88
Arellano and Bond test for AR(2) in first-differences		0.120		0.334
Hansen test of over-identifying restrictions		0.067		0.709

Notes: Country and time (Time) fixed effects are included in the OLS specifications (SGMM specifications), but here not reported. In the SGMM estimations all variables are treated as endogenous, except for the time dummies. To avoid excessive instrument proliferation, the lags of the instrumented variables are truncated at one in first differences and at two in levels in all specifications. Robust clustered standard errors are reported for OLS in brackets; in the case of two-step SGMM the errors are also subject to Windmeijer's (2005) correction. ***, ** and * denote statistical significance levels at 1, 5 and 10%, respectively. For the two tests, p-values are reported, when applicable.

We next trimmed the first and last percentile of all variables to be able to explore Gonçalves and Rodrigues' (2017) claim, cited in Section 2, of the significant economic growth-REER misalignment link being driven solely by outliers. Our results, available upon request, are very similar to our baseline findings, hence refuting Gonçalves and Rodrigues' (2017) conclusions.

One general issue with SGMM estimation is the bias that can derive from instrument proliferation, as discussed in Section 5.1.1. An attempt to attenuate the potential overfitting of the endogenous variables was conducted in the baseline specifications by limiting the number of lags of the instruments. In Table E6 we show that by allowing all instrument lags to be employed, but by treating as endogenous only the REER misalignment and their interactions, our baseline SGMM results are confirmed.

Table E6. REER misalignments and economic growth: SGMM robustness by changing lag number

(dependent variable: average annual GDP per capita growth in 5-year periods)

	(1)	(2)
Initial real GDP per capita (ln)	-0.013**	-0.012***
	(0.006)	(0.004)
Absolute REER misalignment (5-yr mean; pctge. pts.)	-0.038***	
	(0.011)	
Positive REER misalignment (5-yr mean; pctge. pts.)		-0.060***
		(0.017)
Negative REER misalignment (5-yr mean; pctge. pts.)		0.038***
		(0.011)
Gross domestic savings rate (5-yr mean; in pctge. of GDP)	-0.061	0.015
	(0.075)	(0.059)
Number of observations/number of countries	401/54	401/54
Number of instruments	43	148
Arellano and Bond test for AR(2) in first-differences	0.031	0.78
Hansen test of over-identifying restrictions	0.313	0.992

Notes: ***, ** and * denote statistical significance levels at 1, 5 and 10%, respectively. Time fixed effects are included, but here not reported. Robust clustered standard errors are subject to Windmeijer's (2005) correction. Only REER misalignments and their interactions are treated as endogenous. For the three tests, p-values are reported, when applicable. The lags of the instrumented variables are not truncated.

We next split the country panel between advanced and emerging economies. Baseline findings are broadly confirmed for both country groupings and, in particular, undervaluations are found not to be conducive to growth in emerging economies, running counter to Rodrik's (2008) findings.

Table E7. REER misalignments and economic growth: advanced vs. emerging economies

(dependent variable: average annual GDP per capita growth in 5-year periods)

	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)	(4a)	(4b)
	Advanced economies				*Emerging economies*			
	OLS	SGMM	OLS	SGMM	OLS	SGMM	OLS	SGMM
Initial real GDP per capita (ln)	-0.053***	-0.037***	-0.052***	-0.031***	-0.052***	-0.026	-0.052***	-0.024
	(0.005)	(0.006)	(0.005)	(0.006)	(0.008)	(0.026)	(0.008)	(0.014)
Absolute REER misalignment (5-yr mean; pctge. pts.)	-0.022**	-0.026**			-0.053***	-0.033*		
	(0.009)	(0.013)			(0.010)	(0.018)		
Positive REER misalignment (5-yr mean; pctge. pts.)			-0.034***	-0.025*			-0.062***	0.024
			(0.010)	(0.014)			(0.022)	(0.101)
Negative REER misalignment (5-yr mean; pctge. pts.)			0.007	-0.003			0.050***	0.032**
			(0.011)	(0.019)			(0.010)	(0.013)
Gross domestic savings rate (5-yr mean; in pctge. of GDP)	0.094***	0.143***	0.105***	0.143***	0.121***	-0.118	0.116***	-0.104
	(0.022)	(0.032)	(0.022)	(0.034)	(0.037)	(0.220)	(0.038)	(0.137)
Adjusted R-squared	0.821		0.824		0.708		0.698	
Number of observations/number of countries	259/35	259/35	259/35	259/35	140/19	140/19	140/19	140/19
Number of instruments		68		68		88		88
Arellano and Bond test for AR(2) in first-differences		0.395		0.278		0.065		0.12
Hansen test of over-identifying restrictions		0.999		1.000		1.000		1.000

Notes: Country and time (Time) fixed effects are included in the OLS specifications (SGMM specifications), but here not reported. In the SGMM estimations all variables are treated as endogenous, except for the time dummies. To avoid excessive instrument proliferation, the lags of the instrumented variables are truncated at one in first differences and at two in levels in all specifications. Robust clustered standard errors are reported for OLS in brackets; in the case of two-step SGMM the errors are also subject to Windmeijer's (2005) correction. ***, ** and * denote statistical significance levels at 1, 5 and 10%, respectively. For the two tests, p-values are reported, when applicable.

In Table E8 we show that labour misallocation results are confirmed even for the smaller county sample for which capital data are available, suggesting that sample selection does not drive the different findings between the two types of misallocation.

Table E8. The link between REER misalignments and labour misallocation in the restricted country sample

	Dependent variable: SDI (nominal,5-yr mean)		Dependent variable: dispersion in labour frictions (5-yr mean)	
	(1a)	(1b)	(2a)	(2b)
	OLS	SGMM	OLS	SGMM
Initial real GDP per capita (ln)	-0.051***	-0.026***	-0.046***	-0.018*
	(0.007)	(0.010)	(0.006)	(0.010)
Absolute REER misalignment (5-yr mean; pctge. pts.)	0.123**	0.135*	0.075*	0.157*
	(0.058)	(0.084)	(0.045)	(0.083)
Gross domestic savings rate (5-yr mean; in pctge. of GDP)	0.245***	0.584***	0.378***	0.719***
	(0.078)	(0.171)	(0.075)	(0.136)
Adjusted R-squared	0.363		0.467	
Number of observations/number of countries	203/35	203/35	203/35	203/35
Number of instruments		41		41
Standard F-statistic	29.07		39.06	
Effective F-statistic (critical value; 30% worst-case bias)	9.50 (12.04)		17.29 (12.04)	
Arellano and Bond test for AR(2) in first-differences		0.160		0.310
Hansen test of over-identifying restrictions		0.700		0.693

Notes: In the SGMM estimations all variables are treated as endogenous. To avoid excessive instrument proliferation, the lags of the instrumented variables are truncated at one in first differences and at two in levels in all specifications. Robust clustered standard errors are reported for OLS in brackets; in the case of two-step SGMM the errors are also subject to Windmeijer's (2005) correction.***, ** and * denote statistical significance levels at 1, 5 and 10%, respectively.

Next, we replace the dependent variable of equation 10 alternatively with one of the three rough proxies of other possible channels of influence of REER misalignments (Table E9). REER misalignments, and in particular undervaluations, are found to be significantly and causally correlated only with the FCD external debt share (as in Grekou, 2018).[49]

Table E9. The link between REER misalignments and foreign-currency-denominated external debt, within-sector production factor misallocation and export diversification

A. OLS

	Dependent variable					
	FCD external debt share (pctges)	FCD external debt share (pctges)	Private credit-to-GDP ratio (5-yr mean)	Private credit-to-GDP ratio (5-yr mean)	Imports-to-GDP ratio (5-yr mean)	Imports-to-GDP ratio (5-yr mean)
	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)
Initial real GDP per capita (ln)	-0.118***	-0.121***	0.017***	0.016***	-0.739**	-0.740**
	(0.014)	(0.021)	(0.002)	(0.002)	(0.368)	(0.294)
Absolute REER misalignment (5-yr mean; pctge. pts.)	0.462***		-0.041***		0.807	
	(0.092)		(0.013)		(1.187)	
Positive REER misalignment (5-yr mean; pctge. pts.)		0.918***		0.055**		-4.747*
		(0.218)		(0.023)		(2.608)
Negative REER misalignment (5-yr mean; pctge. pts.)		-0.428***		0.051***		-0.796
		(0.082)		(0.013)		(1.123)
Gross domestic savings rate (5-yr mean; in pctge. of GDP)	0.767***	0.758***	0.128***	0.136***	12.251***	12.047***
	(0.104)	(0.097)	(0.043)	(0.043)	(2.417)	(2.387)
Adjusted R-squared	0.262	0.275	0.286	0.337	0.026	0.029
Number of observations/number of countries	402/54	402/54	306/41	306/41	351/48	351/48
Standard F-statistic	90.55	58.76	77.79	34.02	35.40	27.78
Effective F-statistic (critical value; 30% worst-case bias)	28.64 (12.04)	14.6 (8.75)	11.31 (12.04)	7.14 (8.16)	0.53 (12.04)	4.21 (8.18)

Notes: This is the first step of a two-step feasible GMM TSLS. The first column is based on one instrument (the absolute value of REER misalignments), the second column on two instruments (positive and negative REER misalignments). Robust and clustered standard errors are reported in brackets. ***, ** and * denote statistical significance levels at 1, 5 and 10%, respectively.

B. SGMM

	Dependent variable					
	FCD external debt share (pctges.)	FCD external debt share (pctges)	Private credit-to-GDP ratio (5-yr mean)	Private credit-to-GDP ratio (5-yr mean)	Imports-to-GDP ratio (5-yr mean)	Imports-to-GDP ratio (5-yr mean)
	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)
Initial real GDP per capita (ln)	-0.078***	-0.086***	0.020***	0.021***	-0.128	-0.171
	(0.019)	(0.026)	(0.004)	(0.005)	(0.261)	-0.629
Absolute REER misalignment (5-yr mean; pctge. pts.)	0.411***		-0.006		0.735	
	(0.125)		(0.023)		(0.871)	
Positive REER misalignment (5-yr mean; pctge. pts.)		0.300		0.037		-3.077
		(0.220)		(0.038)		(2.461)
Negative REER misalignment (5-yr mean; pctge. pts.)		-0.417***		0.021		-1.636
		(0.100)		(0.014)		(1.778)
Gross domestic savings rate (5-yr mean; in pctge. of GDP)	0.71	0.904*	0.214***	0.214***	8.784	10.746
	(0.438)	(0.488)	(0.082)	(0.068)	(6.394)	(9.971)
Number of observations/number of countries	402/54	402/54	306/41	306/41	351/48	351/48
Number of instruments	41	61	41	61	41	61
Arellano and Bond test for AR(2) in first-differences	0.348	0.527	0.040	0.040	0.201	0.209
Hansen test of over-identifying restrictions	0.158	0.524	0.451	0.973	0.999	0.997

Notes: All variables are treated as endogenous. To avoid excessive instrument proliferation, the lags of the instrumented variables are truncated at one in first differences and at two in levels in all specifications. Robust clustered standard subject to Windmeijer's (2005) correction are reported.***, ** and * denote statistical significance levels at 1, 5 and 10%, respectively.

[49] In the first-stage OLS regression private credit appears to be significantly linked to REER imbalances, but the effective F-statistic points to the latter being a weak instrument of the former.

As our baseline results concerning undervaluations are opposite to those in Rodrik (2008), in Table E10 we test whether this could be due to the different country sample. In particular, we focus solely on the emerging economies in our sample, and estimate regressions 11 and 12 by employing the share of employment in non-tradable sectors (as defined in Section 4.1) as a simple proxy of misallocation, following from Rodrik's (2008) model. In the first-stage regressions REER misalignments are found to be negatively associated with the share of non-tradable employment; in particular, the larger the REER undervaluations, the smaller the share of workers engaged in non-tradable activities, to the advantage of the tradable employment share, in the spirit of Rodrik (2008).[50] In the second stage, however, the component of the non-tradable employment share explained by REER imbalances appears not to significantly affect real economic performance; in other terms, the growth-enhancing effect of the expansion of the more productive tradable sectors induced by a REER undervaluation is not borne out by our data relative to medium-income countries. Plausibly, this effect is hence only relevant for countries that have a very low income, herein not considered, because of data constraints.

Table E10. The link between REER misalignments, the non-tradable employment share and economic growth in emerging economies

A. First-stage regressions

	Labour misallocation	
	Dependent variable: Employment share in "non-tradable" sectors (5-yr mean)	
	(1a)	(1b)
Initial real GDP per capita (ln)	0.099***	0.106***
	(0.004)	(0.005)
Absolute REER misalignment (5-yr mean; pctge. pts.)	-0.129**	
	(0.038)	
Positive REER misalignment (5-yr mean; pctge. pts.)		0.060
		(0.039)
Negative REER misalignment (5-yr mean; pctge. pts.)		0.123***
		(0.030)
Gross domestic savings rate (5-yr mean; in pctge. of GDP)	-0.196***	-0.166**
	(0.053)	(0.054)
Adjusted R-squared	0.980	0.766
Number of observations/number of countries	118/14	118/14
Standard F-statistic	339.99	697.90
Effective F-statistic (critical value; 30% worst-case bias)	20.09 (12.04)	11.2 (3.00)

[50] The positive sign of initial GDP per capita instead confirms that the more advanced these emerging economies are, the larger the share of workers engaged in non-tradable activities, such as some tertiary sectors.

B. Second-stage regressions (cont. Table E10)

	Underlying labour misallocation instrument: employment share in "non-tradable" sectors (5-yr mean)	
	(1a)	(1b)
Initial real GDP per capita (ln)	-0.01	-0.014
	(0.014)	(0.011)
Across-sector production factor misallocation (5-yr mean)	-0.042	-0.004
	(0.136)	(0.107)
Gross domestic savings rate (5-yr mean; in pctge. of GDP)	0.111***	0.115***
	(0.037)	(0.036)
Adjusted R-squared	0.980	0.982
Number of observations/number of countries	118/14	118/14
Number of excluded instruments	1	2
Hansen J test of over-identifying restrictions	-	0.557

Notes: Two-step feasible GMM TSLS are employed. The first column is based on one instrument (the absolute value of REER misalignments), the second column on two instruments (positive and negative REER misalignments). Robust and clustered standard errors are reported in brackets. ***, ** and * denote statistical significance levels at 1, 5 and 10%, respectively.

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