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Editorial

Misallocation and productivity ☆

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ABSTRACT

A large portion of differences in output per capita across countries is explained by differences in total factor productivity (TFP). In this article, we summarize a recent literature — and the articles in this special issue on misallocation and productivity — that focus on the reallocation of factors across heterogeneous production units as an important source of measured TFP differences across countries.

1. Introduction

Why are some countries so much richer than others? This is one of, if not *the* most important questions in all of economics. During the last twenty years the profession has made considerable progress in diagnosing the proximate sources of the variation in income per capita across countries. Work by Klenow and Rodriguez-Clare (1997), Prescott (1998), and Hall and Jones (1999) argued that the dominant source of differences in output per worker is differences in total factor productivity (TFP), as opposed to either the amount of physical or human capital per worker.[1]

But what is the underlying cause of low TFP in poor countries? Much of the literature effectively approaches this question from the perspective of asking why individual firms in one country would have lower TFP than their counterparts in another country, and emphasizes two possibilities. One is that firms in some countries are relatively slow to adopt more productive technologies.[2] The other is that firms in some countries do not operate technologies efficiently.[3] In recent years the literature has adopted a new perspective regarding cross-country differences in TFP: rather than asking why individual firms in one country might be less productive, this new literature starts from the perspective that in an economy with heterogeneous production units, aggregate TFP depends not only on the TFP's of the individual production units but also on

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[1] See also Caselli (2005) and Hsieh and Klenow (2010) for recent surveys.

[2] Applications of this idea in different contexts include for example Nelson and Phelps (1966), Aghion and Howitt (1992), and Parente and Prescott (1994). See also Comin and Hobijn (2010) for an examination of technology adoption patterns across countries.

[3] See, for example, Parente and Prescott (1999, 2000), Schmitz (2005), Bloom and Van Reenen (2007) and Bloom et al. (forthcoming).

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how inputs are allocated across these production units.[4] That is, aggregate TFP can be low because inputs are *misallocated* across heterogeneous production units.[5]

A simple model is useful to illustrate the concept of misallocation. Consider a static economy that has a collection of heterogeneous establishments, indexed by i, that produce a single good. Establishment i has a value added production function denoted by $z_i f(k_i, h_i)$ where k_i and h_i are capital and labor inputs of establishment i, z_i is an establishment-specific productivity term, and f is a strictly concave function. There is a fixed cost associated with operating an establishment, denoted by $\bar{y}$ and denominated in units of output. The economy is endowed with K units of capital and H units of labor, both of which are supplied inelastically. There is a representative agent that has preferences that are increasing in consumption of the single good.

In this framework, both slow adoption of technology and inefficient use of technology would be reflected in lower values for the establishment-level productivities z_i. In contrast, misallocation captures effects that occur holding the values of the z_i fixed. An efficient allocation in this economy will maximize final output (i.e., output net of fixed costs) and is characterized by two components: the first component determines which establishments will operate (i.e., which establishments pay the fixed cost), and the second component determines the allocation of labor and capital across those establishments that operate.[6] But if either of these decisions is distorted, the economy will have lower (net) output, which would manifest itself as lower aggregate TFP since aggregate factor inputs are constant.

But are differences in this type of misallocation quantitatively important in accounting for aggregate TFP differences both in the cross-section and the time series? Answering this question requires that we measure the amount of misallocation. And if the extent of misallocation is important, what underlying factors are generating the misallocation? And through what channels do these factors operate? These are the questions that the literature on misallocation seeks to answer and that the papers in this volume speak to.

In the next section we summarize some key contributions from the existing literature. Section 3 introduces the articles that appear in this issue. These articles represent important contributions to the literature on misallocation and productivity. They illustrate both the scope and depth of work that is being done to further our understanding of the role of misallocation. The papers develop extensive new data sets to examine misallocation in a variety of contexts across time and space: in historical data for the US, both in the late 1800s and during the Great Depression, in India and China during the last three decades, in Chile and Colombia during the 1980s, as well as the current US economy. The papers also study a variety of different sources of misallocation: financial frictions, trade restrictions, and a host of regulations associated with industrial policy. Some of the papers propose new mechanisms that amplify the TFP effects of policies that generate misallocation. To facilitate replication and further research progress, detailed information on the data (which is also available when possible), the programs used to manipulate the data, and the programs used to obtain results are available at:

http://www.economicdynamics.org/RED-misallocation.htm.

Section 4 concludes and describes what we see as some important open issues for future work.

2. Assessing misallocation

There are two main approaches that the literature has followed in its attempt to provide answers to the questions posed in the introduction, which we will refer to as the *direct* approach and the *indirect* approach. In this section we describe each of the two approaches, and summarize some of the contributions from the literature that have followed each of the approaches.

2.1. The direct approach

The essence of the direct approach is to pick one (or more) factors that are thought to be empirically important sources of misallocation, try to obtain direct measures of these factors, and then use a model of heterogeneous production units to quantitatively assess the extent to which these factors generate misallocation and impact aggregate TFP.

Many factors lend themselves to this type of analysis. Hopenhayn and Rogerson (1993) is an early example. Using the industry equilibrium model of Hopenhayn (1992), they showed that firing taxes distort the allocation of labor across establishments and that empirically reasonable values for this tax could generate TFP losses on the order of about 5%. In related work, Lagos (2006) uses a matching model to show analytically how policies such as unemployment insurance and employment protection affect TFP via selection effects regarding which matches are formed in equilibrium.

[4] One motivation for this emphasis comes from the importance of resource reallocation across productive units in aggregate productivity growth. For instance, in US manufacturing, 50 percent of productivity growth is explained by reallocation across plants (see Baily et al., 1992; and Foster et al., 2001). See also Foster et al. (2008).

[5] As Jones (2011b) notes, misallocation of inputs within establishments may also help to explain why some establishments have low TFP conditional on the technology that they are using.

[6] While the decision to not operate an establishment is equivalent to giving it zero inputs, it is nonetheless useful to separately distinguish the selection issue.

In related work, Guner et al. (2008) study how what they term "size-dependent policies" lead to misallocation in a version of the Lucas (1978) span of control model. At a general level, they consider policies with the property that the effective tax rate that an establishment faces depends on its size. Real world examples that they study include policies that limit the size of manufacturing establishments in India, the size of retail establishments in Japan, and employment protection policies in Italy that only take effect beyond a certain size threshold. They study configurations of size-dependent policies that result in a given reduction in average establishment size in the model. Policies that reduce average size by 20 percent produce a decrease in output of more than 8 percent.

The analysis of trade barriers also lends itself naturally to the direct approach. Trade barriers are an interesting factor to study given that there is strong empirical evidence linking barriers to trade and aggregate productivity; see for example Alcalá and Ciccone (2004) for cross-country evidence, Pavcnik (2002) for evidence on trade reform in Chile, and Lileeva and Trefler (2010) for evidence on the impact of reductions in US tariff rates on firm productivity in Canada. Additionally, the trade literature has expanded rapidly in considering variations of the frameworks in Eaton and Kortum (2004), Melitz (2003), and others where the impact of trade policy on aggregate productivity is emphasized.[7] Waugh (2010) argues that trade barriers are a source of productivity dispersion in manufacturing across countries, whereas Tombe (2012) emphasizes trade barriers as a source of both low productivity in agriculture and the lack of trade in food in poor countries. Epifani and Gancia (2011) argue that trade barriers influence the amount of competition and hence markups, and that heterogeneity in markups induced by trade barriers is also a source of misallocation of resources.

Regulation, heavy taxation, and a myriad of costs of doing business in the formal sector are often claimed to be responsible for the prevalence of informal establishments in developing countries. The study of informality in the context of misallocation is relevant not only because informality is a prevalent form of business operation in poor countries, but also because informality is often associated with small scale, unproductive production. Some recent studies have attempted to assess the productivity losses associated with informality. Leal (2010), for example, studies the role of taxes and regulations in explaining informality and low productivity in Mexico, and D'Erasmo and Moscoso Boedo (2012) study informality across countries in the context of a model with financial frictions.[8]

Perhaps the single most studied channel in terms of generating misallocation is that of credit market imperfections. Banerjee and Duflo (2005) have summarized microeconomic evidence pointing to misallocation of capital due to credit constraints and institutional failures, among others, as an important source of productivity differences across countries.[9] The list of papers pursuing this particular avenue is too large for us to review them individually, so in the interests of space we note a few that have produced direct calculations of TFP effects.[10] While details differ somewhat, the key idea in this literature is that credit market imperfections can lead to both selection and misallocation effects. Specifically, credit constraints may prevent some productive establishments (or entrepreneurs) from operating. But in addition to selection effects on the quality of entrepreneurs that operate, credit constraints may limit the amount of capital that some establishments (or entrepreneurs) have access to, thereby inducing misallocation of capital across establishments.

In various settings, Erosa (2001), Amaral and Quintin (2010), Buera et al. (2011), Caselli and Gennaioli (forthcoming) and Midrigan and Xu (2010) have all produced estimates of the effects of various sorts of credit market imperfections on TFP. The general range of effects is wide, pointing to some disagreement as to the importance of this channel in explaining TFP differences across countries. One key issue in this literature is the persistence of productivity differentials and the ability of establishments to overcome credit market constraints through self-financing (e.g., Banerjee and Moll, 2010).[11]

Udry (2012) reviews the microeconomic evidence on the importance of credit constraints for understanding the large productivity gaps between rich and poor countries. He argues that the evidence is suggestive of some role for credit constraints exerting influence on manufacturing productivity in developing countries, but does not support a significant role for the credit channel in helping us to understand low productivity in agriculture in poor countries. However, some work does suggest a role for other factors to generate low productivity in agriculture via misallocation. Adamopoulos and Restuccia (2011) study misallocation across farms in the agricultural sector in explaining low productivity in agriculture in poor countries. These authors emphasize the role of inheritance rules, progressive taxes and subsidies in agriculture, land reforms and tenancy restrictions, among many others as potential sources of distortions to farm size in poor countries. A quantitative assessment of a specific land reform in the Philippines reveals a large negative impact on productivity in agriculture.

In summary, the literature features many studies that seek to explore the extent to which specific policies, institutional factors and market imperfections can generate effects on aggregate TFP via misallocation. While many studies indicate that TFP losses on the order of several percentage points are possible from individual factors, with the exception of a few studies

[7] See for instance, Bernard et al. (2003), Melitz and Ottaviano (2008), Bustos (2011), Rubini (2011), and Ferreira and Trejos (2011).

[8] Other studies addressing the role of scale of operation and entry costs for misallocation and productivity include Barseghyan and DiCecio (2011), and Moscoso Boedo and Mukoyama (2012). Aghion et al. (2008) study the productivity effects of dismantling the License Raj in across Indian states with different labor market regulations.

[9] See also Banerjee et al. (2003) and Banerjee and Munshi (2004).

[10] In addition to the papers that we note below, other contributions include Boyd and Prescott (1986), Greenwood and Jovanovic (1990), Jeong and Townsend (2007), Erosa and Hidalgo Cabrillana (2008), and Cole et al. (2012).

[11] Moll (2012) develops a tractable model that provides analytic expressions for the relationship between persistence of shocks, credit constraints and steady state TFP.

that have found relatively large effects from credit market imperfections, the effects from any one particular factor are very small relative to the scale of differences found across rich and poor economies.

2.2. The indirect approach

An appealing feature of the direct approach just described is that it attempts to assess the importance of specific underlying sources in generating TFP effects via misallocation. However, this approach also faces an important limitation. There are many factors that one might reasonably imagine to be important sources of misallocation that are extremely difficult, in some cases perhaps nearly impossible to measure directly. For example, think of all of the special arrangements that individual companies may negotiate, or the preferential treatment that my be conferred upon them. Firms with political connections may receive favorable treatment through a multitude of channels in some countries: special low interest loans, special tax breaks, subsidies, measures to reduce competition from rivals, the awarding of government contracts, among many others. The list would include all of the many factors that are associated with corruption and "crony capitalism".

A priori, we do not have any way of knowing how important the easily measurable factors relative to the not-so-easily measurable factors might be. Motivated by this issue, the *indirect* approach tries to focus on the net effect of the entire bundle of underlying factors on misallocation without reference to the specific underlying factors.

The starting point for the indirect approach is the observation that any factors that create misallocation can be thought of as generating wedges in the first order conditions of establishment optimization problems.[12] This suggests that for some issues it may be useful to focus on the wedges rather than on the underlying source of the wedges. In this spirit, Restuccia and Rogerson (2008) consider a simple version of the Hopenhayn (1992) model, the steady state of which looks very much like the static model that we described above, though they abstracted from the selection effects by assuming that $\bar{y} = 0$. They assume that each establishment faces an idiosyncratic proportional tax rate on output, denoted by τ_i, with the proceeds funding a lump-sum transfer to households. Note that the τ_i's can be either positive or negative, so the taxes can be designed to have zero net surplus. Uniformly high values of these taxes can discourage economic activity, leading to lower capital accumulation, lower labor supply and hence lower output, but would not necessarily show up as lower TFP. But since variation in the τ_i acts to distort the allocation of inputs across establishments, it can lead to lower output that would be reflected in lower aggregate TFP.[13] Taking the supply of factors to be exogenous and inelastic, one can solve for the equilibrium exit decisions regarding operation and the allocation of factors across establishments given the establishment-specific tax rates.

In the context of this structure one can ask two general questions. First, for a given variation in idiosyncratic tax rates, what influences the size of their impact on aggregate TFP? Second, how big is the variation in these tax rates, or wedges? To the extent that the answers to these questions suggest an important role for misallocation, it is of course important to try to isolate the underlying sources of the wedges, which is the focus of the direct approach.

Restuccia and Rogerson (2008) focus on the first question, examining the conditions under which the misallocation caused by these generic distortions leads to larger effects on aggregate TFP. They found that to generate large TFP losses it was necessary that the taxes be negatively correlated with establishment-level productivity, i.e., that the taxes on productive establishments would have to be higher. Large variation in tax rates that were uncorrelated with establishment characteristics led to relatively minor losses of TFP in their analysis.

In subsequent work, Restuccia (forthcoming) and Bello et al. (2011) consider an additional channel. Specifically, in the context of our simple static example, assume that the distribution of productivities represent *iid* draws from some distribution, with cdf $G(z)$. But now assume that this distribution is influenced by an effort decision — reflecting the fact that the idea that someone comes up with depends on the effort that they expend. In this case, if the idiosyncratic taxes fall more heavily on establishments that end up with high realizations then there will be less effort devoted in the initial stage and the overall distribution of the z_i's will fall, thereby amplifying the effects of the idiosyncratic distortions.

Hsieh and Klenow (2012) also argue for the effects of misallocation on the distribution of productivities. Specifically, they document that the life cycle evolution of manufacturing plants varies across countries, and that in Mexico and India, employment increases less with plant age than in the US. They argue that this is consistent with the idea that various policies serve to create larger distortions on large plants, thereby decreasing the intangible investments that younger plants would typically make to lead to productivity growth over the life cycle. Because productivity growth is depressed, so is employment growth.

But how large is the variation in these tax rates, or wedges? The mere fact that one can produce a large list of factors that might serve to distort the allocation of resources across establishments is not evidence that the variation in wedges is large. A key paper in advancing the effort to answer this question is Hsieh and Klenow (2009). They use micro data on plants in the manufacturing sector in China, India and the United States to measure the size of establishment-specific tax rates.[14] While Restuccia and Rogerson (2008) assumed a single distortion for simplicity, Hsieh and Klenow allow for two

[12] This is in the same spirit for example of the business cycle accounting literature, see Chari et al. (2007).

[13] Note that these types of distortions on output or inputs create a wedge in prices across establishments. For this reason, Restuccia and Rogerson (2008) refer to them as *idiosyncratic* distortions to emphasize the establishment-specific nature of the distortion that can create misallocation.

[14] Whereas our simple example featured heterogeneous establishments producing a homogeneous goods with a decreasing returns to scale technology, Hsieh and Klenow assume instead that firms produce differentiated products using a constant returns to scale technology.

distortions: one to output and one to the capital–labor ratio. The basic idea is to estimate the extent to which marginal revenue products are not equated across establishments, thereby generating estimates of the establishment-specific tax rates. They find that the extent of dispersion in estimated tax rates measured in this fashion are much larger in China and India than in the United States. Moreover, they calculate that if the variance of tax rates in China and India were reduced to the levels found in the United States, TFP would increase by 30 to 50 percent in China and 40 to 60 percent in India. This remains the single strongest piece of evidence in support of the idea that misallocation is an important component of cross-country differences in TFP.[15]

It is relevant to note that the misallocation that Hsieh and Klenow measure is within narrowly defined manufacturing sectors, so that to the extent that misallocation also occurs across these narrowly defined sectors or in other sectors, their estimates are a lower bound on the total amount of misallocation. Also, because they only study establishments with positive production, their estimates do not reflect any selection effects in entry and exit. However, there are also some reasons why these estimates may overstate the extent of misallocation. Because the basis for the estimation is to look for differences in the marginal revenue product of factors across establishments, one has to begin with a functional form for marginal revenue products. Any misspecification at this stage, such as neglecting or mismeasuring adjustment costs, neglecting differences in technologies across establishments that might show up as different functional forms, among many others, could result in an overstatement of the extent of misallocation.[16] Similarly, measurement error could also lead to an overstatement of the extent of misallocation. To be sure, Hsieh and Klenow were aware of these potential issues and for this reason included estimates for the United States in their calculations as a way to allow for some of these factors. The extent to which this adjustment is satisfactory remains an open question.

In addition to assessing the role of misallocation in accounting for cross-sectional differences in TFP between China, India and the United States, Hsieh and Klenow also ask whether changes in misallocation are an important source of aggregate TFP growth for China and India over time. China and India are exhibiting catch up to the leading countries, and given the various reforms taking place in each country, it is reasonable to think that diminishing misallocation might be an important component of the catchup. As a caveat, we note again that the Hsieh and Klenow calculations only refer to misallocation within narrowly defined sectors, and that it is perhaps less clear whether specific reforms will predominately operate along this dimension. In any case, they find that distortions are decreasing in China over the period 1998 to 2005, whereas distortions are relatively stable or increasing in India for the period 1987–1994. In both India and China, the results suggest that larger plants should expand at the expense of smaller plants.

Another key paper in this literature is the recent work by Bartelsman et al. (forthcoming), who use a slightly different method to measure the amount of misallocation. Efficient allocations in the simple model that we described in the opening section have the property that size and establishment-level TFP are positively correlated. That is, more productive establishments receive more inputs. This suggests that another way to assess the extent of misallocation is to assess the extent to which establishment-level TFP and size are correlated. Implementing this requires that one obtains measures of establishment-level TFP.[17] A subtle but important observation in this context is that one needs establishment-level price indices in order to calculate establishment-level TFP. If one only has industry level price indices then the resulting calculation of establishment-level TFP will confound higher prices with higher productivity.[18]

Bartelsman et al. have data that allows them to implement their analysis for a sample consisting of the United States and seven European economies, including some transition economies in central and eastern Europe, for the period 1992–2001. Their analysis also considers selection effects, since given measures of establishment-level TFP they can assess the extent to which the distribution of TFPs for operating establishments differs across economies. The dispersion of aggregate TFP is much smaller for their sample of countries than in Hsieh and Klenow. Nonetheless, they find large effects on aggregate TFP from the presence of idiosyncratic distortions, predicting that output could be improved by as much as 15% in some countries by improving the allocation of resources across establishments. In particular, they find that the allocation of resources was particularly distorted in the transition economies of eastern and central Europe at the beginning of their sample. Their work also shows that additional work is needed to develop models that can capture the key differences across countries in the moments that link establishment-level TFP, revenue and size.

[15] An important limitation of the indirect approach in Hsieh and Klenow is the requirement of detailed and comparable micro data on establishments which is often severely restricted in its access. Nevertheless, there have been numerous attempts in following the Hsieh and Klenow methodology for other countries yielding similar findings of substantial misallocation relative to the United States. For instance, Pages (2010) summarizes the findings from selected countries in Latin America and Kalemli-Ozcan and Sorensen (2012) study misallocation of capital in Africa using the Enterprise Survey of the World Bank.

[16] See, for instance, Asker et al. (2011).

[17] The paper by Alfaro et al. (2009) adopts a similar approach, but without measuring how establishment-level TFP distributions differ across countries. Specifically, they assume that in the absence of distortions, the size distributions would be the same in all countries, and infer distortions given this assumption. They find that distortions are an important source of cross-country differences in TFP.

[18] Because of this issue the literature has introduced two different notions of TFP. TFP-R measures TFP based on revenue deflated with industry level price indices, whereas TFP-Q measures TFP based on revenue deflated with establishment-level price indices. See Foster et al. (2008) for a discussion of this issue, as well as the paper by Eslava et al. in this volume.

3. Papers in this issue

One of the questions that we noted above concerned the issue of what features influence the impact of a given set of distortions on aggregate TFP. The papers by Bhattacharya et al. and Gabler and Poschke both address this question. The essence of the idea in each paper can be described in the context of our simple example. There we assumed that the distribution of establishment-level productivities, the z_i, were exogenously given. But suppose that the z_i reflect the combination of some initial heterogeneity $\hat{z}_i$ in combination with an investment decision, denoted by x_i, so that $z_i = g(\hat{z}_i, x_i)$. Intuitively, there may be heterogeneity in the quality of ideas across firms or entrepreneurs, but developing these ideas requires additional resources. In this setting, the distortions τ_i will influence the investment decision and hence the distribution of the z_i. This mechanism has the potential to amplify the effects of a given set of distortions since the distortions not only create misallocation given the distribution of the z_i but also can produce a shift in this distribution.[19]

The papers by Bhattacharya et al. and Gabler and Poschke develop a version of this basic idea in two different contexts. In contrast to our simple static example, both papers specify a dynamic model in which the steady state distribution of the z_i will be influenced by the presence of idiosyncratic distortions. Bhattacharya et al. study an overlapping generations version of the Lucas span of control model. In their model, individuals are born with some managerial ability, and augment their managerial ability over the life cycle by making investment decisions. A key assumption in this setup is that more able managers invest more in productivity than lower ability managers. This assumption is motivated by the implication in standard human capital accumulation models whereby more able individuals invest more in schooling quantity and quality to attain higher earnings. Each manager also faces an idiosyncratic distorting tax, and these taxes distort the investment decision. More specifically, the authors consider correlated idiosyncratic taxes where more productive managers face larger taxes. Since higher productivity is partly achieved by higher managerial investment, correlated distortions discourage this investment in productivity. In the calibrated version of their model, the reduction in TFP due to idiosyncratic distortions is 60 percent larger than in the model that abstracts from the investment decision.

Gabler and Poschke cast their analysis in the industry equilibrium model of Hopenhayn, but extend it to allow establishments to invest resources in "experimentation", which can lead to increases in next period's productivity. The distortion that an establishment faces is determined by its productivity, and as a result the distortion affects the amount of resources invested in experimentation. In the calibrated version of their model they find that the effects are 100% larger than in the model that abstracts from the endogenous determination of productivity.

The second question that we posed concerned measuring the size of overall distortions found in the data. The papers by Brandt et al., Ziebarth, Bollard et al., and Oberfield all contribute to this question by either extending the analysis pioneered by Hsieh and Klenow (2009) or applying it to new settings. As noted previously, Hsieh and Klenow measured the extent of misallocation within narrowly defined manufacturing sectors. It is clearly of interest to ask about the extent of misallocation more broadly. The paper by Brandt et al. does this in the context of China, by considering misallocation along two margins which are often thought to be distorted by policies and institutions in China: the allocation of economic activity across regions and the allocation of economic activity between the state and private sectors. A key input into this analysis is the construction of a data set with consistent measures of inputs and outputs based on ownership type and region. Using this data covering the period 1985 to 2007, the authors conduct an accounting exercise to assess the overall TFP losses due to misallocation and the proportion of these loses attributed to misallocation of factors across state and non-state sectors (within provinces) and across provinces (within sectors). The authors find an overall TFP loss in the non-agricultural sector due to the sources of misallocation considered on the order of 20 percent. More than half of this loss is attributed to the misallocation of factors across state and non-state sectors. Interestingly, while the authors find declining TFP losses in the first decade in the sample, the losses have increased since the mid 90s and this reversal is attributed to misallocation of capital between state and non-state sectors.

We previously noted that the Hsieh and Klenow (2009) study reported some results about the time series changes in the extent of misallocation and its contribution to time series changes in TFP for both India and China. The paper by Bollard et al. carries out a more extensive analysis of how changes in misallocation have contributed to TFP growth in India. Specifically, whereas Hsieh and Klenow presented evidence for the period 1987 to 1994, this paper studies the much longer period of 1980 to 2004. During this period, various institutional changes have taken place in India, making it of considerable interest for assessing the potential role of misallocation. Data limitations are paramount, and an important contribution of the paper is the construction of a suitable data set for the analysis. Nonetheless, data limitations force the authors to focus on a subset of large manufacturing firms in the formal sector. This sector only represents 20% of total employment in manufacturing in India. This subset is still of great interest since as a whole these large firms exhibit very rapid TFP growth over the period being studied. The key finding is that changes in misallocation account for only a small part of the overall increases in TFP, with the upper limit being 33%. Instead, the dominant source of TFP improvements among these firms seems to come from within firm increases in TFP.[20] Returning to issues we discussed much earlier, the authors cannot tell whether this increase came from improvements in efficiency or the adoption of better technologies. Additionally, exploiting the differences in the

[19] We note that the empirical results in Hsieh and Klenow (2009) about misallocation in China and India relative to the United States also point to differences in the distribution of the z_i as an important factor in explaining low aggregate productivity in these countries, see for example their Fig. 1.

[20] Bollard et al. study misallocation across a set of large firms in India. It is plausible that policies and institutions in India generate misallocation within the firm which will affect firm level productivity growth. There is evidence on misallocation of talent in India. The caste system created a social and

timing of reforms across sectors, the authors find little relation between improvements in TFP due to improved inter-firm allocation and the timing of reforms.

The Hsieh and Klenow finding of much greater misallocation in the Chinese and Indian economies than in the United States is viewed as very plausible for the reason that many prominent institutional and policy features of China and India will intuitively generate misallocation. Ziebarth adds a historical context to this study that turns out to be quite revealing. Specifically, he constructs an establishment-level data set for manufacturing in the United States in the latter part of the 19th century and uses it to carry out the same exercise as Hsieh and Klenow. The level of development in the United States at that time is comparable to the level of development in modern day China and India. The striking result that he finds is that the US manufacturing sector in the late 19th century displays the same extent of misallocation as do modern day India and China. To the extent that the late 19th century US economy did not exhibit any of the distinctive policy or institutional features that are prominently mentioned as potential drivers of misallocation in modern day China and India, this finding suggests that there may be a more widespread set of factors that link development and misallocation. Exploring these in a rigorous fashion remains an important open issue.

Our discussion thus far has focused on secular changes in TFP. In addition to the large differences in TFP across countries, it is well known that TFP also exhibits large changes at business-cycle frequencies. In particular, TFP is known to decline during many downturns in economic activity. An open question is whether these business-cycle frequency changes in TFP might represent changes in misallocation. Oberfield takes a first step in this direction by examining the time series changes in misallocation in the Chilean economy during the crisis of 1982, a period in which manufacturing TFP dropped by around 10%.[21] He utilizes a micro-level data set for manufacturing firms in the Chilean economy and performs an analysis similar to that of Hsieh and Klenow. In particular, Oberfield decomposes the overall change in TFP into a misallocation component from within industry reallocation (across establishments) and across industries. His main finding is that misallocation across industries accounts for about a third of the changes in TFP during the crisis whereas the misallocation within industries barely changes.

The papers by Bond et al., Eslava et al., Gilchrist et al., Caggese and Cuñat, and Greenwood et al. contribute to what we termed the direct approach. Tariffs are a classic example of distortions to inter-firm allocations. And the Smoot–Hawley Bill in 1930 represents one of the largest tariff increases in US history. The paper by Bond et al. studies the impact of these tariff increases for aggregate TFP. As noted above, what matters for TFP effects is not the average level of distortions, but rather the variation in distortions or what we termed idiosyncratic distortions. For this reason, it is important to obtain tariffs at a very disaggregated level in order to best measure the effects on TFP. A key contribution of the paper by Bond et al. is the construction of such a data set covering the US economy in the period both before and after the enactment of the Smoot–Hawley Bill. Having done so they then construct a model that can be used to assess the quantitative impact of the changes in tariffs on TFP and welfare. The Smoot–Hawley Bill increased not only the average tariff but also the dispersion in tariff rates. For instance, Bond et al. document an average tariff rate of 32 percent before the bill. The average tariff rate increased to 46 percent on impact of the bill and to 59 percent in 1933 taking into account the impact in tariffs caused by specific import duties and price changes (deflation during the Great Depression). The increase in dispersion in tariffs rates is substantial: dispersion more than doubles after the implementation of the bill. The authors calculate a uniform equivalent tariff rate that increases from 47 percent prior to the bill to 68 percent after the bill. Although the changes in the level and variation of tariffs is very large, they nonetheless find that the effects on aggregate TFP are relatively minor, only on the order of -0.5%. However, the decrease in TFP associated with the impact of the bill represents an increase of 50% in the cost of tariff barriers relative to free trade prior to the implementation of the Smoot–Hawley Bill.

Eslava et al. focus on a different episode of large changes in tariffs: the trade reform undertaken by Colombia in the early 90s. They then look for evidence that this reduction in tariffs, and in particular the reduction in the variation in tariffs, was associated with evidence of improved allocation of resources. The channel on which they focus is establishment exit. The basic idea is that if decisions are not distorted, it is low productivity establishments that should exit. For example, in the context of our simple static model described earlier, an efficient allocation will have a threshold rule for which establishments should operate, i.e., only those establishments with z_i greater than some $\bar{z}$ should remain in operation. With this in mind they ask whether the exit decision became more tightly connected to productivity after the reforms. A key issue for this analysis is the construction of establishment-level measures of true productivity as opposed to revenue productivity, which can confound high productivity with high prices. The authors find that productivity became much more important as a determinant of exit following the trade reform, and that in simulations this effect together with improved resource allocation were the dominant sources of TFP growth in Colombia following the reform.

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economic gap between disadvantaged and non-disadvantaged casts. The evidence shows strong convergence in education, occupations, and wages in the last three decades among these groups, see for instance Hnatkovska et al. (2012). It remains an interesting issue for future work to assess the connection of reforms in India, changes in the allocation of talent, misallocation, and productivity growth.

[21] There is a literature on great depressions that is closely related to misallocation. Cole and Ohanian (1999) have argued that from the perspective of neoclassical growth theory, the Great Depression in the United States was puzzling not only because of the implied large drop in productivity but also the slow recovery that followed. Cole and Ohanian (2004) argue that new deal policies were responsible for the slow recovery. Great depressions are remarkably prevalent around the world, even in recent past, and Kehoe and Prescott (2002) summarize the evidence and the papers of a special issue in the Review of Economic Dynamics of great depressions in the twentieth century. Also related is a literature on the real effects of financial crises in developing countries, see for instance Pratap and Urrutia (2012).

Another classic example of distortions that generate misallocation are credit market distortions. Gilchrist et al., Caggese and Cuñat, and Greenwood et al. study this particular type of distortion. The paper by Gilchrist et al. measures the variation in interest rates facing large US firms. In particular, they use information on interest rate spreads on outstanding firm's publicly-traded debt for a subset of US manufacturing firms. Using this data, Gilchrist et al. construct effective borrowing costs for firms within this sample. Even though the sample consists of large firms in the manufacturing sector in the US, the authors find a large variation in borrowing rates: the average of firm-specific credit spreads is 240 basis points with a standard deviation of 160 basis points. The authors then feed these differences into a model to assess the implications for TFP. Despite the fact that the variation in borrowing rates is very large, the effects on aggregate TFP turn out to be relatively small, only on the order of 1 to 2%.

The paper by Caggese and Cuñat studies the impact of credit constraints in a model that features trade. Recent models of trade emphasize fixed costs associated with the decision to export. If credit constraints influence the ability of firms to cover these fixed costs then it follows that credit constraints may interfere with the efficient allocation of resources, much like in the spirit of financing constraints on the section of individuals to be entrepreneurs. Caggese and Cuñat build a model that incorporates this feature, calibrate the model using panel data of Italian firms in the manufacturing sector, and evaluate the size of the effects. They find that financing constraints reduce the productivity gains associated with trade reform by as much as 25 percent as selection into the export market is severely distorted.

The paper by Greenwood et al. uses a new theory of financial market imperfections, based on their earlier work (see Greenwood et al., 2010) in order to assess the effects of differences in financial development on cross-country differences in output. Their model extends the earlier analyses of Townsend (1979) and Williamson (1986) that were based on costly state verification along two dimensions. First, they allow for an intensive margin in the monitoring technology. Second, they allow for differences in expected returns across investment projects. They calibrate their model to match certain features of the US economy and then use observed credit spreads to infer the level of financial development in other countries. They find that if all countries in their sample were to adopt the best practices financial intermediation technology, TFP would increase on average by 12%. In Uganda, the country in their sample with the lowest level of financial development, the increase would be 23%.

Often economic reforms are motivated by market frictions that prevent economic activity to achieve full potential. Some examples of this type of motivation are the "infant industry" argument for trade protection in Latin America during the 60s, selective industrial policy in East Asian countries, and micro finance arrangements in poor countries such as Thailand. The final paper in the issue by Buera et al. addresses how these good policy intentions generate idiosyncratic distortions with negative long-run productivity effects, hence, the authors offer a novel theory concerning the source of misallocation. As we noted earlier, one issue in this literature is obtaining measures of the underlying sources of misallocation. Buera et al. consider a scenario in which an economy has some imperfection that leads to misallocation, and assume that the government institutes a set of establishment-specific transfers that decrease misallocation in a static sense, but which then become permanently entrenched. They develop this theory in the context of policies meant to counteract imperfect credit markets. A key implication of their analysis is that when the distortions are first introduced they can lead to what appears to be a short period of "miracle growth" that is ultimately followed by a period of deterioration. Basically, a fixed set of establishment-specific "taxes" might improve allocations today but worsen them in the future as the productivity of establishments is mean reverting. Hence, miracles and disasters might reflect the dynamics of misallocation associated with the initial adoption of policies that are good in a short-run perspective but bad from a long-run perspective. This is an intriguing theory of medium run cycles in TFP and one that requires careful attention in future work.

4. Conclusion and future directions

Despite some headway in recent years, isolating the key factors that can account for the large differences in aggregate TFP in both the cross-section and time series in a variety of contexts remains a somewhat elusive yet hugely important goal. The idea that misallocation of inputs across heterogeneous establishments could play a large role is a relatively new possibility, and in our view a promising one. Previous work by Hsieh and Klenow (2009) in the context of China, India and the United States remains a key piece of evidence to support this view.

While we think that substantial progress has been made in assessing the potential role for misallocation and the specific channels through which misallocation occurs, there is still much work to be done, some of which faces serious challenges. In our view the most persuasive evidence in support of the role of misallocation will come from work that follows the direct approach in specific contexts, especially those in which we observe changes in some underlying source of misallocation and can measure the resulting change in misallocation and aggregate TFP. Several of the papers in this special issue have pushed in this direction, though with mixed results in terms of evidence in support of large effects associated with misallocation. But additional work on direct measurement of distortions and misallocation in more contexts is clearly required. While the last ten years have seen an unprecedented increase in the availability of micro data sets at the establishment level, the issues of data availability and data quality and comparability still serve as important constraints. Also, Jones (2011a) suggests an important caveat regarding studies that focus on specific distortions: there may be important complementarities among distortions, leading to important non-linearities.

More work is also required on the various mechanisms that might serve to amplify the impact on aggregate TFP of various policies that lead to misallocation, specifically on how misallocation might influence technology adoption and innovation. Two of the papers in this special issue take important steps in this direction. Connecting structural models of misallocation to micro data in a more complete and rigorous fashion remains an important avenue for additional progress. We think the recent work of Bartelsman et al. (forthcoming) is an important step in this direction. While the existing literature has focused on misallocation of the quantity of labor and capital, we think that broadening the scope of the analysis to also consider misallocation in talent will also be of interest.

The papers in this special issue serve to illustrate the many fronts on which progress is being made, and the types of contributions that are important in making additional advances in this area. We hope that they will help spur additional work on this important topic.

References

Adamopoulos, T., Restuccia, D., 2011. The size distribution of farms and international productivity differences. Manuscript, University of Toronto.

Aghion, P., Howitt, P., 1992. A model of growth through creative destruction. Econometrica 60 (2), 323–351.

Aghion, P., Burgess, R., Redding, S., Zilibotti, F., 2008. The unequal effects of liberalization: Evidence from dismantling the License Raj in India. American Economic Review 98 (4), 1397–1412.

Alcalá, F., Ciccone, A., 2004. Trade and productivity. Quarterly Journal of Economics 119 (2), 612–645.

Alfaro, L., Charlton, A., Kanczuk, F., 2009. Firm-size distribution and cross-country income differences. In: NBER International Seminar on Macroeconomics 2008, pp. 243–272. NBER Chapters.

Amaral, P., Quintin, E., 2010. Limited enforcement, financial intermediation, and economic development: A quantitative assessment. International Economic Review 51 (3), 785–811.

Asker, J., Collard-Wexler, A., De Loecker, J., 2011. Productivity volatility and the misallocation of resources in developing economies. NBER Working Paper 17175, National Bureau of Economic Research, Inc.

Baily, M., Hulten, C., Campbell, D., 1992. Productivity dynamics in manufacturing plants. Brooking Papers on Economic Activity: Microeconomics, 187–267.

Banerjee, A., Duflo, E., 2005. Growth theory through the lens of development economics. In: Handbook of Economic Growth, vol. 1A. North-Holland. Chapter 7.

Banerjee, A., Moll, B., 2010. Why does misallocation persist? American Economic Journal: Macroeconomics 2 (1), 189–206.

Banerjee, A., Munshi, K., 2004. How efficiently is capital allocated? Evidence from the knitted garment industry in Tipur. Review of Economic Studies 71, 19–42.

Banerjee, A., Duflo, E., Munshi, K., 2003. The (mis)allocation of capital. Journal of European Economic Association 1 (2–3), 484–494.

Barseghyan, L., DiCecio, R., 2011. Entry costs, industry structure, and cross-country income and TFP differences. Journal of Economic Theory 146 (5), 1828–1851.

Bartelsman, E., Haltiwanger, J., Scarpetta, S., forthcoming. Cross-country differences in productivity: The role of allocative efficiency. American Economic Review.

Bello, O., Blyde, J., Restuccia, D., 2011. Venezuela's growth experience. Latin American Journal of Economics 48 (2), 199–226.

Bernard, A., Eaton, J., Jensen, J., Kortum, S., 2003. Plants and productivity in international trade. American Economic Review 93 (4), 1268–1290.

Bloom, N., Van Reenen, J., 2007. Measuring and explaining management practices across firms and countries. Quarterly Journal of Economics 122 (4), 1351–1408.

Bloom, N., Eifert, B., McKenzie, D., Mahajan, A., Roberts, J., forthcoming. Does management matter: Evidence from India. Quarterly Journal of Economics.

Boyd, J., Prescott, E., 1986. Financial intermediary-coalitions. Journal of Economic Theory 38 (2), 211–232.

Buera, F., Kaboski, J., Shin, Y., 2011. Finance and development: A tale of two sectors. American Economic Review 101 (5), 1964–2002.

Bustos, Paula, 2011. Trade liberalization, exports, and technology upgrading: Evidence on the impact of mercosur on Argentinian firms. The American Economic Review 101 (1), 304–340.

Caselli, F., 2005. Accounting for cross-country income differences. In: Aghion, P., Durlauf, S. (Eds.), Handbook of Economic Growth. North-Holland.

Caselli, F., Gennaioli, N., forthcoming. Dynastic management. Economic Inquiry. http://dx.doi.org/10.1111/j.1465-7295.2012.00467.x.

Chari, V.V., Kehoe, P., McGrattan, E., 2007. Business cycle accounting. Econometrica 75, 781–836.

Cole, H., Ohanian, L., 1999. The Great Depression in the United States from a neoclassical perspective. Federal Reserve Bank of Minneapolis Quarterly Review 23, 2–24.

Cole, H., Ohanian, L., 2004. New deal policies and the persistence of the Great Depression: A general equilibrium analysis. Journal of Political Economy 112 (4), 779–816.

Cole, H., Greenwood, J., Sanchez, J., 2012. Why doesn't technology flow from rich to poor countries? Manuscript, University of Pennsylvania.

Comin, Diego, Hobijn, Bart, 2010. An exploration of technology diffusion. The American Economic Review 100 (5), 2031–2059.

D'Erasmo, P., Moscoso Boedo, H., 2012. Financial structure, informality and development. Journal of Monetary Economics 59 (3), 286–302.

Eaton, J., Kortum, S., 2004. Technology, geography, and trade. Econometrica 70 (5), 1741–1779.

Epifani, P., Gancia, G., 2011. Trade, markup heterogeneity and misallocations. Journal of International Economics 83 (1), 1–13.

Erosa, A., 2001. Financial intermediation and occupational choice in development. Review of Economic Dynamics 4 (2), 303–334.

Erosa, A., Hidalgo Cabrillana, A., 2008. On finance as a theory of TFP, cross-industry productivity differences, and economic rents. International Economic Review 49 (2), 437–473.

Ferreira, P., Trejos, A., 2011. Gains from trade and measured total factor productivity. Review of Economic Dynamics 14 (3), 496–510.

Foster, L., Haltiwanger, J., Krizan, C.J., 2001. Aggregate productivity growth. Lessons from microeconomic evidence. In: New Developments in Productivity Analysis. National Bureau of Economic Research, Inc., pp. 303–372. NBER Chapters.

Foster, L., Haltiwanger, J., Syverson, C., 2008. Reallocation, firm turnover, and efficiency: Selection on productivity or profitability? American Economic Review 98 (1), 394–425.

Greenwood, J., Jovanovic, B., 1990. Financial development, growth, and the distribution of income. Journal of Political Economy 98 (5 part 1), 1076–1107.

Greenwood, J., Sanchez, J., Wang, C., 2010. Financing development: The role of information costs. American Economic Review 100 (4), 1875–1891.

Guner, N., Ventura, G., Xu, Y., 2008. Macroeconomic implications of size-dependent policies. Review of Economic Dynamics 11 (4), 721–744.

Hall, R., Jones, C., 1999. Why do some countries produce so much more output per worker than others? Quarterly Journal of Economics, 83–116.

Hnatkovska, V., Lahiri, A., Paul, S., 2012. Castes and labor mobility. American Economic Journal: Applied Economics 4 (2), 274–307.

Hopenhayn, H., 1992. Entry, exit, and firm dynamics in long run equilibrium. Econometrica 60, 1127–1150.

Hopenhayn, H., Rogerson, R., 1993. Job turnover and policy evaluation: A general equilibrium analysis. Journal of Political Economy 101 (5), 915–938.

Hsieh, C., Klenow, P., 2009. Misallocation and manufacturing TFP in China and India. Quarterly Journal of Economics 124 (4), 1403–1448.

Hsieh, C., Klenow, P., 2010. Development accounting. American Economic Journal: Macroeconomics 2 (1), 207–223.

Hsieh, C., Klenow, P., 2012. The life-cycle of plants in India and Mexico. NBER Working Paper 18133.

Jeong, H., Townsend, R., 2007. Sources of TFP growth: Occupational choice and financial deepening. Economic Theory 32 (1), 179–221.
Jones, C., 2011a. Intermediate goods and weak links in the theory of economic development. American Economic Journal: Macroeconomics 3 (2), 1–28.
Jones, C., 2011b. Misallocation, economic growth, and input–output economics. Working Paper w16742, National Bureau of Economic Research.
Kalemli-Ozcan, S., Sorensen, B., 2012. Misallocation, property rights, and access to finance: Evidence from within and across Africa. NBER Working Paper 18030.
Kehoe, T., Prescott, E., 2002. Great depressions of the 20th century. Review of Economic Dynamics 5 (1), 1–18.
Klenow, P., Rodriguez-Clare, A., 1997. The neoclassical revival in growth economics: Has it gone too far?. In: Bernanke, B., Rotemberg, J. (Eds.), NBER Macroeconomics Annual. MIT Press, Cambridge, MA.
Lagos, R., 2006. A model of TFP. Review of Economic Studies 73 (4), 983–1007.
Leal, J., 2010. Informal sector, productivity, and tax collection. Manuscript, CIDE Mexico.
Lileeva, A., Trefler, D., 2010. Improved access to foreign markets raises plant-level productivity… for some plants. Quarterly Journal of Economics 125 (3), 1051–1099.
Lucas, R., 1978. On the size distribution of business firms. Bell Journal of Economics 9, 508–523.
Melitz, M., 2003. The impact of intraindustry trade reallocations and aggregate industry productivity. Econometrica 71 (6), 1695–1725.
Melitz, M., Ottaviano, G., 2008. Market size, trade, and productivity. Review of Economic Studies 75 (1), 295–316.
Midrigan, Virgiliu, Xu, Daniel Yi, 2010. Finance and misallocation: Evidence from plant-level data. Working Paper No. w15647, National Bureau of Economic Research.
Moll, B., 2012. Productivity losses from financial frictions: Can self-financing undo capital misallocation? Manuscript, Princeton University.
Moscoso Boedo, H., Mukoyama, T., 2012. Evaluating the effects of entry regulations and firing costs on international income differences. Journal of Economic Growth 17 (2), 143–170.
Nelson, Richard R., Phelps, Edmund S., 1966. Investment in humans, technological diffusion, and economic growth. The American Economic Review, 69–75.
Pages, C., 2010. The Age of Productivity: Transforming Economies from the Bottom Up. Palgrave MacMillan, New York.
Parente, Stephen L., Prescott, Edward C., 1994. Barriers to technology adoption and development. Journal of Political Economy, 298–321.
Parente, S., Prescott, E.C., 1999. Monopoly rights: A barrier to riches. American Economic Review 89, 1216–1233.
Parente, S., Prescott, E.C., 2000. Barriers to Riches. MIT Press, Cambridge, MA.
Pavcnik, N., 2002. Trade liberalization, exit, and productivity improvements: Evidence from Chilean plants. Review of Economic Studies 69, 245–276.
Pratap, Sangeeta, Urrutia, Carlos, 2012. Financial frictions and total factor productivity: Accounting for the real effects of financial crises. Review of Economic Dynamics 15 (3), 336–358.
Prescott, E.C., 1998. Needed: A theory of total factor productivity. International Economic Review 39, 525–552.
Restuccia, D., forthcoming. The Latin American development problem: An interpretation. Economía.
Restuccia, D., Rogerson, R., 2008. Policy distortions and aggregate productivity with heterogeneous establishments. Review of Economic Dynamics 11 (4), 707–720.
Rubini, L., 2011. Innovation and the elasticity of trade volumes to tariff reductions. Manuscript, Universidad Carlos III de Madrid.
Schmitz, J., 2005. What determines productivity? Lessons from the dramatic recovery of the U.S. and Canadian iron ore industries following their early 1980s crisis. Journal of Political Economy 113 (3), 582–625.
Tombe, T., 2012. The missing food problem: How low agricultural imports contribute to international income and productivity differences. Manuscript, University of Calgary.
Townsend, R.M., 1979. Optimal contracts and competitive markets with costly state verification. Journal of Economic Theory 21, 256–293.
Udry, C., 2012. Misallocation, growth and financial market imperfections. Manuscript, Yale University.
Waugh, M., 2010. International trade and income differences. The American Economic Review 100 (5), 2093–2124.
Williamson, S.D., 1986. Costly monitoring, financial intermediation, and equilibrium credit rationing. Journal of Monetary Economics 18, 159–179.