The impact of structural reforms on multi-factor productivity: new evidence from macroeconomic estimates

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Empirical research on the drivers of multi-factor productivity (MFP) is abundant (Bartelsman et al., 2004; Syverson, 2011). Differences in plant level productivity may be due to the distortion in the allocation of capital and labor (Bartelsman et al. 2014) Evidence suggests that these distortions are partly driven by labor and product market regulations and FDI restrictions (Andrews and Cingalo, 2014). Studies at the industry level identify a negative relation between the stringency of product market regulation and MFP (Nicoletti and Scarpetta, 2003) and that the negative impact transits through the impact of regulation on R&D (Cette et al., 2013). Labor market regulations are also found to matter for MFP at the sector level (Cette et al., 2014). It is common wisdom that innovation intensity and trade openness boost MFP at the macroeconomic level (Isaksson, 2007). Yet there is surprisingly little empirical evidence on the impact of structural policies and institutions on aggregate MFP.

Against this background, this paper investigates the drivers of aggregate MFP for a panel of 34 OECD countries covering about 30 years at annual frequency. In particular, we estimate the impact of product and labor market regulations and the quality of institutions on country-level MFP. We analyze whether policies interact with each other, whether the quality of institutions influences the impact of policies and the extent to which cross-country variation in policies and institutions help understand the dispersion of MFP across countries.

I. Data and Modeling Issues

A. Measuring MFP

Mismeasuring the level and dynamics of MFP has important implications. It determines growth at the country level. It also affects the frontier level to which convergence is supposed to take place in the long run. We calculate MFP as the residual of output once all inputs including capital and labor are accounted for. Cross-country comparability of MPF levels is ensured by using the purchasing power parity exchange rate (the ratio of

absolute price levels in the domestic and reference country), which accounts for different levels of economic development[1].. We compute a number of alternative aggregate MFP measures and find that whether human capital is included or excluded from MFP matters the most. The other parameters, including the type of PPP rate to make MFP levels comparable across countries, alternative measures of capital and labor input, matter to a lesser extent. MFP series, which exclude human capital (output minus human and physical capital and labor) are implausible: a decline over decades in countries close to the frontier, the US far from the frontier. Therefore, MFP measures included human capital will be used in the empirical analysis,

B. Empirical Specification

In our baseline specification, the level of MFP is regressed on trade openness, adjusted for country size, innovation intensity and a measure of product market regulation.

It is widely accepted that MFP depends on the creation, transmission and absorption of knowledge. Innovation intensity and trade openness capture these phenomena. More stringent product market regulation (PMR) can hamper MFP by impeding the efficient allocation of capital and labor within and across firms and industries. PMR is approximated by the OECD's electricity, transport and communications regulation (ETCR) indicator, a subset of the OECD's Product Market Regulation (PMR) indicator: it has annual observations and covers our sample period. The degree of product market regulation is measured on a scale of 0 to 6. Higher values indicate more restrictive regulation.

Labor market regulation (LMR) can also bear an impact on MFP through the direct effects of the allocation of labor resources and the indirect impact on capital reallocation. We use three indicators capturing LMR: i.) per capita spending on active labour market policies (ALMP), iii.) the employment protection legislation (EPL) indicator (for permanent contracts), and iii.) the gross unemployment benefit replacement rate.[2]

Sector- and firm-level studies typically include the absolute productivity frontier in the estimated equations. The coefficient estimate on the productivity frontier gives the extent of convergence to the frontier. Using the absolute productivity frontier at the macroeconomic level is tricky. First, at the

[1] Our MFP calculation is based on 2005 PPPs

[2] These data are borrowed from Gal and Theising (2015).

firm or industry level, productivity is compared for relatively homogenous firms and industries. At the aggregate level, however, composition effects may play an important role. Second, if the country at the productivity frontier is small, it is unreasonable to expect that large countries would converge to it. In our dataset, Luxembourg and Norway are often found to be at the absolute MFP frontier. To alleviate the second problem, the MFP level of the USA will be used as the MFP frontier in our empirical analysis.

An alternative would be to model MFP levels without convergence to the absolute MFP frontier. In such a setup, one would seek to establish the drivers of MFP levels and convergence would take place towards the estimated, country-specific long-run relationship in an error correction framework. However, year fixed effects introduced into the cointegration analysis are akin to the use of an MFP frontier. But the frontier given by year fixed effects is more flexible than using a country or group of countries as the MFP frontier: it actually captures the common trend for all countries in a panel setting that is allowed to change over time. The covariates used in such regressions explain the gap between the common trend and country-specific MFP developments, i.e. by how much countries diverge from this common trend due to the covariates. In most of our empirical analysis, we will use both country and year fixed effects in the regressions.

II. Estimation Results

A. Linear models

There exists a strong positive link between overall *R&D expenditures* and MFP.[3] This is not a very surprising finding. Nevertheless, looking at R&D subcomponents shows that this result is driven by the part of R&D funded by industry. At the same time, R&D funded by the government is either statistically not significant or has a negative relationship with MFP. This negative finding does not change when entering public R&D with long lags (5, 10 and 10 years) or when entering private and public R&D in the regressions at the same time. Second, R&D on basic research has a positive relationship to MFP. The economic importance of R&D on basic research, as opposed to general or business R&D is considerably larger. A one percentage point increase in spending on basic research results in a roughly 0.3 percent rise in MPF. This is 10 times larger than the impact of overall R&D. Also, and relatedly, the Nobel Prize

[3] The long-term coefficients are estimated using the Dynamic OLS (DOLS) estimator proposed by Stock and Watson (1993).

variable is found to be statistically significant and with a positive sign: more Nobel Prize winners translate into higher MFP. The effect is not very large though: any additional Nobel Prize winner pushes MPF up by 0.003 percent.

Trade openness, adjusted for country size, is positively related to MFP. The coefficient estimates are very stable in magnitude and are statistically significant at the 5% level in the baseline specifications (Table 3). Trade openness is the most robust determinant of MFP. It withstands the probe of a shorter time period, the use of alternative MFP measures and a large number of extended specifications, reported later on. The only instance when the standard errors on openness are large is when a subgroup of 17 OECD countries is looked at. Again, this suggests that less developed countries benefit more from technology diffusion and adoption through the trade and capital flow channel.

The strong negative relationship between aggregate ETCR (and its subcomponents barriers to entry and public ownership) and MFP holds only if country fixed effects are used (Table 4a). If both country and time fixed effects are included into the regressions, only the coefficient estimate on public ownership is found to be statistically significant, overall ETCR and barriers to entry have large standard errors.

Labor market regulations are not very robust drivers of MFP in a linear estimation framework. Whether or not they are precisely estimated depends very much on the sample size.

The absolute productivity frontier (US MFP series) comes out strongly, mostly with a coefficient lower than 1. This indicates an incomplete pass-through from MFP frontier to country-specific MFP levels. That is, a one percent rise in frontier (USA) MFP will be reflected, on average, in a less than one percent increase in MFP in other OECD countries. The use of the absolute productivity frontier does not change too much the results for the other MFP drivers.

B. Policy interactions

Threshold regressions are employed to analyze policy interactions. In such a setting, the impact of one policy on MFP could depend on the level of another policy. Several interesting results emerge from this analysis. *First*, openness and private R&D spending substitute for each other. The positive openness effect is smaller if private R&D spending is high and the positive link between R&D spending and MFP breaks down at very high levels of openness. *Second*, we can identify a two-way interaction between product and labor market regulations. ETCR's

negative impact on MFP is at work only if EPL is low, that is if employment protection legislation is not very binding. At the same time, there is a strong negative relation linking EPL and MFP if ETCR indicates less stringent product market regulation and a positive relationship in the case of more stringent product market regulation. *Third*, the negative impact of ETCR doubles in size for very high levels of trade openness. Most probably, considerable external competitiveness pressures may exacerbate the importance of the impact of public ownership in downstream sectors. *Finally*, various labor market regulations interact with each other. ALMP's positive influence on MFP only works if EPL is low. The rationale for this finding is that improved labor market matches through higher ALMP spending can only work if it is relatively easy to reallocate labor. A stringent EPL would precisely prevent this. Also, higher ALMP spending is found to attenuate some of the negative labor tax wedge effect

C. Policies and Institutions

Most of the benefits of better institutions transits through the channel of R&D spending. The estimation results show that the quality of institutions enhance the MFP-boosting effect of R&D spending. A higher rule of law and better law enforcement amplify the positive effect of R&D spending, whether it is funded by industry or spent on basic research. More costly and lengthy contract enforcement offsets some of the benefits of higher R&D spending.

Better educational outcomes, measured by the OECD's PISA scores in sciences, amplify the positive effects on MFP of R&D spending. Better PISA results reflect improved human capital. This can signal the quality of R&D spending, the ease at which new innovations can be implemented and used by industry but also the ability of a country to adopt foreign technology diffused via foreign trade and investment.

Longer and more costly insolvency procedures are found to attenuate the positive impact of R&D on MFP. Similarly, the benefits of R&D will be reduced if it takes longer to start a business.

Better enforcement of laws also implies a more pronounced negative ETCR impact: regulations are more binding if they are applied more strictly.

Finally, it appears that more stringent regulation on FDI and a more pronounced differential treatment of foreign suppliers exacerbates the negative ETCR effect. Innovation intensity interacts with the same regulations.. The positive sign on the interaction between innovation and FDI

restrictiveness could perhaps indicate that less competition in domestic markets could help reap the benefits of R&D.

D. Level Effects of Policies and Institutions

Previous results are based on regressions including country fixed effects. They tell us how changes in policies are related to changes in MFP on average in our panel. But they do not tell why the level of MFP may differ across countries. MFP series have substantial cross-country variation and the cross-country variation is fully captured by country fixed effects. The drivers of cross-country dispersion can be analyzed by replacing country fixed effects by some economically meaningful variables.

We swap country fixed effects for four variables, which only have cross-section variation: the country averages of two labor market indicators (EPL and ALMP), barriers to trade and investment and two measures of institutional quality (the rule of law and the time of insolvency procedures – they enter the regressions one by one). The new variables capturing cross-country variation in MFP are statistically significant at the standard 5% level and their sign makes sense economically. More stringent EPL and more restrictive barriers to trade and investment are related to lower MFP levels. At the same time, higher spending on ALMP and better institutions are associated with higher levels of MFP. At the same time, the variables used in earlier estimations are fairly robust to the replacement of country fixed effects: openness and private spending on R&D are precisely estimated and are positively signed. The public ownership part of the ETCR indicator is negatively linked to MFP but it becomes nonsignificant when the time of insolvency procedures is used (instead of rule of law).

These estimates compare reasonable well with earlier results containing country fixed effects. Pooled regressions account for about 40% of the variation in the MFP data. Adding country fixed effects improves the goodness of fit remarkably. Our new set of regressions goes more than half way from pooled regressions to those using country fixed effects: the four additional variables add an extra 30 percentage points to the adjusted R-squared.

III. Conclusions

For an annual panel of OECD countries covering the last three decade, we found that anticompetitive product market regulations are associated with lower MFP levels and that higher innovation intensity and greater openness result in higher MFP. We also found that the impact of product market regulations

on MFP may depend on the level of labor market regulations. Better institutions, a more business friendly environment and lower barriers to trade and investment amplify the positive impact of R&D spending on MFP. Finally, we also show that cross-country MFP variations can be explained to a considerable extent by cross-country variation in labor market regulations, barriers to trade and investment and institutions.

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