Who Benefits From Productivity Growth?
The Direct and Indirect Effects of Local TFP Shocks*

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I Extended Abstract

Economists have long considered productivity growth as a key source of economic progress and improvements in standard of living in the long-run. Indeed, increases in workers' consumption levels are naturally linked to productivity growth in many macroeconomic models (e.g., Solow 1964). This view has led governments all over the world to adopt policies intended to bolster firm productivity.

Yet, in practice it is not clear to what extent productivity gains actually translate into higher real salaries, consumption and workers' welfare.[1] For once, wage growth appear to have fallen behind productivity growth: Over the past two decades, aggregate productivity growth in most OECD countries, including the US, has decoupled from real median compensation growth. In a recent survey of OECD country level aggregate data, Schwellnus, Kappeler and Pionnier (2017) conclude that "raising productivity no longer appears to be sufficient to raise real wages for the typical worker." The share of output that accrues to labor, as opposed to capital, also appears to be declining in many countries in many countries.

It's even less clear how productivity growth might differentially affect workers with different skill levels and therefore how it might affect inequality. While a large literature has focused on skill-biased technical change, much less is know on how changes in total factor productivity affect skilled and unskilled workers. Given the central role that productivity growth plays in our understanding of economic development, it is surprising that the question of who exactly benefits from productivity gains has not been more central to modern economics.[2]

In principle, one way to empirically study how productivity growth affects workers' welfare would be to compare measures of workers' standard of living—real earnings, for example, or consumption—in countries with different rates of productivity growth. In this paper we focus instead on differences across cities *within* in the United States and quantify the local and aggregate effects of city-level productivity growth.

Although not as large as differences across countries, there are substantial productivity differences across cities within the United States, both in levels and in changes over time. In our sample, the cities at the 95th percentile of the TFP gains distribution experienced productivity growth between 1980 and 1990 that was 24 times faster than cities at the 5th percentile. These differences in TFP reflect differences across areas in industry mix—as some industries experience faster productivity gains than others and this benefits cities where these industries are concentrated—differences in investment in transportation infrastructure, local economic policies, productivity spillovers, and other local factors that influence local productivity beyond

[1] Jones and Klenow (2016) propose a measure the well-being of people in a country that incorporates information on consumption, leisure, mortality, and inequality to study how GDP growth affects worker welfare. They argue that while welfare is highly correlated with GDP per capita, deviations are often large.

[2] By contrast, the literature seeking to explain the causes of productivity differences across countries is more developed. For example, see Jones (2016) for a recent overview.

national trends.

The fact that productivity growth is so heterogenous across cities implies that local prices can potentially play an important role in determining its incidence. When an area experiences a localized TFP shock, worker wages might increase but local prices might also adjust, offsetting some of the wage gains. For example, San Francisco and New York City have experienced rapid productivity growth in recent decades, mostly driven by agglomeration of high-tech, bio-tech, finance (Moretti, 2012). But the cost of living has also increased substantially and benefited incumbent landowners while dampening real wage gains in those cities. This point revives the classical concern of Ricardo (YYYY), in which land is in fixed supply and so landowners capture all gains from productivity growth.

As far as incidence is concerned, the split between labor and land is potentially even more consequential than the split between labor and capital that has been the focus of the literature on labor share. Because housing and other non-tradables account for the majority of worker consumption, changes in their cost can have potentially large consequences for worker standard of living.

In this paper, we estimate who benefits from local productivity growth in the United States, and how this incidence varies across skill groups. To identify productivity shocks in practice, we use confidential plant-level data on the universe of establishments from the Census of Manufacturers and estimate changes in Total Factor Productivity for all U.S. manufacturing establishments between 1980 and 1990. We aggregate TFP changes to the level of metropolitan statistical area (MSA) and relate average TFP changes to changes in earnings, housing costs and employment between 1980 and 1990 (medium run effects) and 1980 and 2000 (long run effects). To measure worker standard of living we compute real earnings, defined as nominal earnings deflated by local cost of housing and other non tradables.

Our empirical analysis is made of two parts. We first estimate the impact of local TFP changes on local outcomes—meaning outcomes in the cities that are *directly* affected by TFP changes. We then consider the *indirect* effects across cities due to general equilibrium effects. We argue that a shock to a city's TFP is unlikely to be limited to that city, because in general equilibrium it may indirectly affect the labor and housing markets in other cities. If workers are mobile, a productivity increase in a city might induce in-migration from other cities and, therefore, might affect equilibrium wages and housing costs there. To understand the full incidence of localized productivity shocks, it is therefore important to estimate not only their direct effect in the cities where they occur, but also the indirect effects in other cities that are linked through labor mobility.

In the first part, we identify the local causal effect of local TFP shocks, by focusing on empirical specifications that instrument for changes in productivity using three alternative instrumental variables. The first is a standard 'shift-share" instrument based on the fact that industry-specific nationwide TFP changes affect each MSA differently due to differences in

its initial industry concentration. The second instrument is based on waves of technological change, as measured by changes in patenting activity by technology class. Technological change is considered to be a key determinant of TFP growth. Our instrument is based on the fact that nationwide changes in patenting activity by technology class affect MSA differently due to initial differences in importance of each technology class. The third instrument is based on changes in export activity, as measured by changes in export flows by industry in data from high-income countries other than the US. International trade has been shown to affect investment in R&D (Autor et al., 201X).

The three instruments rely on different identifying assumptions. Importantly, they use different sources of variation: empirically they are largely uncorrelated with each other. They yield estimates that are similar: Overidentification tests fail to reject that the estimates are statistically indistinguishable.

We find that local productivity growth benefits local workers in terms of higher earnings and higher employment. But the benefits for workers who rent their residence are small, as the majority of the earning gains are offset by increases in local cost of living, while the benefits for homeowners are significantly larger. A 1 percent increase in TFP in a MSA is associated with a mean long-run increases of 1.45% in annual earnings, 1.47% in housing rents, and 2.46% in home values. Local employment also increases, especially in the long run, with most of the increase caused by in-migration rather than higher residents' participation.

In terms of real wages, we find that for renters, a 1 percent increase in local TFP increases worker real earnings by 0.59% in the long run. For homeowners—at least those who have bought their property before the TFP shock— gains are almost twice as large: a 1 percentage point increase in local TFP increases their real earnings by 1.11%. Much of the benefits of local productivity gains appear to accrue to resident through the housing market, rather than the labor market.

Importantly, these effects are different depending on worker skill level. Nominal and real wage gains are larger for high school graduates than for college graduates, and for workers at the 10th percentile of income distribution than workers at the 90th percentile. For example, among renters, the long run effect on real wages is 0.53% for high school graduates and only 0.11% for college graduates. For owners, the corresponding figures are 0.95% and 0.57%. This finding is important because it means that local productivity growth compresses local inequality. (Conversely, local TFP declines magnify local inequality.)

In contrast, local employment gains are significantly larger for skilled workers. A 1 percentage point increase in TFP is associated with a 5.82% long-run increase in the number of college graduates in a city and a 3.23% increase in the number of high school graduates. The fact that local TFP gains cause stronger wage growth for less skilled workers and stronger employment growth for high skilled workers likely reflects differences in mobility rates of the two groups. Less-educated workers are known to have lower geographical mobility. Therefore

it is not surprising that they enjoy larger local wage gains and smaller employment gains when labor demand increases due to an increase in TFP.

Thus, despite being a skill-neutral shock, local TFP growth disproportionately benefits the standard of living of less skilled workers in the MSA. Consistent with the prediction of a simple theoretical model and with general economic intuition about incidence, in which the gains from productivity growth accrue most to those factors that are supplied most inelastically, the incidence of local productivity gains falls more on unskilled labor because it is the less mobile factor.

Southern cities experienced particularly large productivity gains in the 1980's —as the region manufacturing sector was catching up with the rest of the country. We find that the rapid growth of TFP in the South resulted in marked declines in inequality.

In the second part of the paper we turn to the indirect effects of local productivity shocks. To see why indirect effects might be important, consider the example where Houston experiences a positive TFP shock, which raises wages and employment there. Attracted by higher wages in Houston, some workers might leave, say, Dallas. In turn, this affects the labor and housing market of Dallas, as the decline in the number of workers changes equilibrium earnings and rents there. Given an upward sloping housing supply and a downward sloping labor demand, outmigration from Dallas will result in lower rents and higher wages there, everything else constant. Presumably, mobility to Houston will continue until the real wage in Dallas has increased enough that the marginal worker is indifferent between the two cities.

One way to estimate this type of general equilibrium effects would be to use a spatial equilibrium model and quantify the indirect effects based on the assumed structure of the model.[3] Here we propose a different strategy, one that is more empirical and instead of relying on the structure of a model only depends an an assumption about labor demand. For each city hit by a TFP shock, we use our estimates of the direct employment effects and information on past mobility flows to estimate employment changes in cities indirectly affected. We then use data on housing supply elasticities by city and an assumption about labor demand elasticity to quantify the indirect effects on housing costs and earnings.

We find that indirect effects are quite important. When city is hit by a TFP shock, the indirect impact on each of the other cities taken in isolation is small, but when it is summed across all other cities, the aggregate indirect impact is remarkably large. Almost half of the earning gains of localized TFP shocks occur *outside* the cities directly hit by the shock. Further, because of higher geographic mobility among college-educated workers, indirect effects are more important for this group. More than two third of earning gains of college graduates caused by TFP shocks take place outside the city hit by the shock. The corresponding figure for high-school graduates is a third. This suggests that neglecting indirect effects would yield a

[3]In a related paper, Hsieh and Moretti (2017) take this approach to estimate general equilibrium effects of TFP differences across cities.

incomplete picture of the ultimate effects of these shocks on inequality.

Summing the direct and indirect effects on earnings, rents and cost of other non-tradables, we find that TFP shocks generated long run gains in real yearly earnings that are similar for high and low skilled workers, but quite different for renters and owners. Put differently, the benefits of localized productivity growth depend more on an individual status in the housing market than on her skills.

Our results complement the well-known finding by the skill biased technical change literature that shocks that favor labor demand of skilled workers tend to increase inequality. In contrast to skill biased technological shocks, which favor skilled workers, TFP shocks are, by construction, skill neutral. Our argument is that during the 1980's the US labor market experienced both skill-biased and skill neutral shocks, and the impact of shocks on inequality was different.