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Abstract

Discussions of the future of jobs are concerned that technological change will displace labor and particularly jobs. In this work it is rarely remarked on the strangeness that some of the most globally scarce factors of high level technical expertise, capability to innovate, and entrepreneurial talent are devoted to economizing on--reducing the demand for--one of the most globally abundant factors: low to medium skill labor. I show that policy based barriers to the mobility of labor have created the largest single price distortion in history and that this price distortion induces biased technological change.

Keywords: mobility of labor, price distortion, technological change
JEL Classifications: J2, J6

1. Introduction

In this paper I want to make two related, but conceptually distinct points.

The points are related in that they both address the same puzzling question: "How and why is it that the world's *scarcest* economic factors (entrepreneurial talent and super-high skilled scientific and engineering skill) are devoted to economizing on the world's most *abundant* factors (low to medium skill labor)?"

A key example is the research into self-driving cars, trucks, and other delivery vehicles. Amazon and Google have made large direct and indirect investments into creating the array of technologies needed to autonomous vehicles. This is absorbing the time and talents of top scientists and engineers. The goal? Reduce costs by economizing on the use of human beings to carry out the tasks of driving vehicles (and the other tasks associated with delivering packages).

The largest single private employer in America is Walmart (according to the latest Fortune 500 ranking it has 2.2 million employees) and is usually thought of as a "low wage" employer (and attracts high profile political criticism for its low wages). Yet key to Walmart's announced $11 billion in investments for upgrading stores are the use of technology to displace labor, including increased use of self-checkout and deployment of technology in functions like floor cleaning, shelf-scanning, and truck unloading. So even at low wages Walmart is acting on the premise that high cost factors like skilled engineers can create a combination of capital and technology that is even cheaper than labor.

Much of the discussion of the "future of work" seems to be based on the premise that both the pace and direction technological change is exogenous and that the key questions for the "future of work" are the implications of these technological changes and how to cope with the inevitable changes technology will bring.

I start with the obvious point that technological change is in part exogenous and shaped and limited by deep characteristics of the physical world, but when one thinks beyond basic science to the broader idea of R&D—research and development—these investments are responsive to prices and the profitability across various investments in R&D creates by relative prices. If market prices reflect true scarcities unleashing the power of profit driven R&D can, and has, produce amazing gains. If, however, market prices don't reflect true scarcities then R&D following those innovations will be, at best, sub-optimal and at worst, damaging.

In this context I proceed to argue that the relative prices facing firms and entrepreneurs in the currently rich industrialized countries are subject to the two largest distortions of prices from true economic scarcities in history.

The first huge distortion is that all industrial economies have created policy based barriers that serve to limit the availability of low and medium skilled labor in these countries. These barriers sustain wage differentials between equal intrinsic productivity labor across borders larger than the

price distortions created by current trade barriers, by two orders of magnitude (at least a factor of 100) and are larger than the largest trade based price distortions ever observed in history. When Amazon or Walmart invest in technologies that displace labor they are doing so not in response to *global* scarcity or availability or cost but to the policy induced distortions for non-tradable labor services induced by policy based barriers to labor mobility.

The second distortion is smaller and is not so much about the cost of labor or "work" per se but about the relative cost of labor embedded in a formal sector job. A big question is whether part of the vision is that the "future of work" will involve less and less "jobs." By "jobs" I mean an employment relationship between a formal sector firm (private or public) that: (a) is expected to be a long-term relationship or "career" (at least past some, perhaps extended, "probationary" period in which there might be large churn it is expected to be terminated only "for cause"), (b) typically involves "benefits" (whether legally mandated or not). There are many phenomena which suggest that, even when firms cannot displace jobs with machines they are looking to move needed work from "jobs" to contractual relationships for "work without a job" by pushing work outside the boundary of the firm, so less "make with workers in jobs" to more "buy" or "push work onto customers." While on the first point I have hard and compelling data and analysis, this latter is more speculative and exploratory of what are the potential features of the economy—and its legal and regulatory environment—that make "jobs" more expensive than "work."

I propose that what has over-turned the natural economic logic that innovation is driven by a desire to economize on the scarce, not the abundant, is over-turned in the case of low to medium skilled labor as a confluence of forces and policy distortions have made the globally abundant factor, low to medium skill labor, expensive to key economic actors (firms in rich countries) which leads them to excessively pursue both labor saving and labor shifting (to shift labor out of jobs) innovation. This pattern of innovation is a massive negative externality to the global economy as what is needed, on many levels (economic, social, political) is jobs for low to medium skill labor.

2. Prices matter for innovation

I am going to argue that two things (nearly) everyone agrees with implies something that (nearly) no one agrees with. What (nearly) everyone agrees with is that in a market economy the pattern of R&D is driven not entirely by the exogenous forces of the change in basic science but is strongly influenced by relative prices (including prices induced by regulation). What nearly no one agrees with is that border based barriers to low (and medium) skill labor in rich countries have created the perverse situation in which the *scarcest resources on the planet are devoted to attempts to economize on one of the most abundant resources on the planet.* The incredibly rare and scarce resources of super-star quality entrepreneurial and scientific, technical and engineering talent are devoted to creating innovations to economize on the use of low/medium skill labor because they are responding to rich country, market distortion induced, *prices,* and not to global supply, availability, or costs.

Let me give two entirely uncontroversial examples of induced innovation.

2.1. Climate change and Carbon Taxes

What nearly every economist agrees with is that if climate change is a large threat to human well-being a carbon tax—or some other way of raising the price of carbon intensive actions and behaviors—is important to addressing that problem. There are two reasons that is important.

The first rationale for increases in carbon prices is the static reallocation of incentives such that all decision makers internalize the externality of carbon emissions. We know if people do not face the full social costs of their decisions in how they fly, how they drive, how they heat their houses, where their houses are (commute times), how they cook, what they eat, etc. it is just too complex to try and nudge or push people into the right consumption and production patterns.

The second, and almost certainly the most important in the long run, is that if actual market prices at which transactions are carried out do not reflect the full social costs and benefits then there will be too little innovation (in the broad sense of both basic science, research, and the development of bringing innovations to market) into carbon use reducing ways of doing things and too much investment into carbon intensive technologies.

In a market system when innovation is potentially profitable at scale this induces deconcentrated, decentralized, bottom-up driven searches that can produce and sustain innovation. And, while there are "public goods" aspects of basic science, it is almost impossible to push ideas through the "development" stage of actually translating ideas into products and processes that lead to scaled use without having prices at which those are cost-recovering and profitable.

(Nearly) everyone agreed that to achieve scaled production of renewable sources of electricity one needed to get the price lower than coal. Now, this may have happened already with some renewables, but everyone agrees that a carbon price that forced coal burning plants to face the full social cost of coal (and a commitment to those prices into the future) would bring the incentives into line so that the innovation did not have to be as highly promoted or subsidized.

The widely recognized point is that a Pigouvian tax in response to an environmental externality creates the right incentives for use and, in the absence of distortions in the research market, also induces the right incentives for research and development as it will induce innovation that reduces abatement costs and therefore further reduce emissions (e.g. Parry 2001).

Regulatory approaches, like bans on certain substances, can also alter current and future anticipated relative prices, and induce innovation. The Montreal Protocol is widely touted as a successful international agreement in abating the threat to the earth's ozone layer. This improvement happened rapidly, and at relatively low cost, as the major producing firms (e.g. DuPont) made major investments in the R&D needed to produce substitutes for ozone depleting substances.

2.2. Pharmaceutical research

A second domain about which there is wide acceptance of the influence of incentives on innovation, for good or ill, is pharmaceuticals. The American health care industry, through the combination of private practice doctors controlling prescriptions, a health insurance structure that was obligated to reimburse medically effective treatments (regardless of cost or cost effectiveness), a regulatory agency who controlled the approval of new drugs, and patents protecting drugs created a powerful incentive for innovation—from basic science, to research and to development and marketing.

This example illustrates the power of structuring incentives via market prices, both for good and ill.

The upside is that this set of incentives has produced a continuous stream of innovation in drugs and medicines that have contributed to improved life expectancy and healthy life status.

At the same time, the industry shows the power of incentives.

First, a system that rewards innovation in efficacy but without any explicit control on costs is at obvious risk for cost escalation as new drugs are invented to come on patent to treat the same conditions are existing drugs going off patent. These new drugs may only have minor health benefits relative to the old drugs and hence, if users had to bear the full cost out of pocket would not have willingness to pay for the new, on patent, medication but since in the structure of incentives with insurance neither prescribing doctor nor using patient pay full cost of medications the incentives are for the invention of new drugs for the same conditions even if social benefits do not exceed social costs.

Second, the incentives will bias drug research into diseases and conditions that have a large paying market, irrespective of the health benefits. For instance, Viagra is a drug that treats erectile dysfunction. While not all of Viagra sales are covered by insurance, well over half are, and the combination of a guaranteed market in a rich country means that this medicine has a large and profitable market. While on patent Viagra generated almost two billion dollars in sales per year (which fell precipitously when Viagra went off-patent as users switch rapidly and massively to the generic version).

Third, there is a lively debate about the best way to promote drug research into conditions that have a small anticipated market, either because they are rare diseases or because they are diseases concentrated in poor countries. Kremer (2000a, 2000b) has proposed "advanced market commitments" in which a fund establishes that they will purchase a given quantity of a medicine that is demonstrated to be effective for drugs that otherwise would have small or risky markets. It is argued this is a way of allowing existing organizations and markets to drive research efforts rather than attempt to drive research by directed grants. Whether or not this is in fact the optimal way to drive research is an open question (see Renwick, et al 2015 on development novel anti-

biotics to address resistance, for instance) but all agree that harnessing the power of the incentives and motivations that allow for non-centrally driven research is a powerful potential.

2.3. The broad and narrow point on innovation

These two examples of climate change and pharmaceuticals are not meant to make the broad point that innovation is induced by relative prices. This broad point is central to explanations of the "hockey stick" of accelerated growth in the (now) richer countries by which the growth of per capita GDP—which had been roughly stagnant for thousands of years—historically accelerated to 1 percent and then 2 percent and the maintenance of that growth created the world we now live in. While economic historians might debate about the relative importance of the advent of basic science, an increased "cultural" acceptance of tinkering towards improvements (McCloskey), the ability of new organizational forms to harness large scale cooperation (Chandler), I think nearly all agree the ability to reliably translate innovation into profitability played a role in creating the high levels of productivity we enjoy today.

The examples are making a narrower point, which is that the extent to which relative prices are aligned with underlying scarcities and hence "true" opportunity costs affects the extent to which innovation produces gains in well-being. *Distorted market prices induce distorted patterns of innovation*.

3. Wage gaps in unskilled labor: the biggest policy induced price distortion ever

My first empirical point is that the current differences across countries in the wage rates for low to medium skilled labor (roughly, workers with less than a tertiary degree and "low" interpreted as less than "high school" and "medium" as "high school" but not tertiary) is the *biggest policy induced price distortion in the history of mankind*.

My intuitive metric for "biggest" is Harberger triangle of the partial equilibrium welfare cost from a price distortion induced by a tariff. The area of the Harberger triangle, like all triangles, is ½ height times base where the height is the difference between the domestic price and the world supply price plus transport costs (the landed price) and the base is the difference in quantity demanded at world price and tariff induced domestic price. So a big distortion is either a big price equivalent distortion is large or a big base and particularly the combination so a big price distortion on a factor that is a third to half of all value added is going to be massive.

3.1. Price equivalent of the barriers to mobility of low skilled labor in the USA

The first, and very hard, empirical question is to ask what the net price effect of the complex set of barriers to the mobility of labor induced by US immigration policy. In international trade theory and empirics there has been considerable attention given to estimating the price equivalents (or tariff equivalent, which is the percentage over the world supply price) of a set of quotas or non-tariff barriers that limit mobility of goods across borders.

For instance, the USA has historically limited the imports of sugar to a certain quota amount and allocates that quota across countries. This means that trade will not equalize prices and that the domestic price of sugar in the USA will be higher than the price at which people in sugar producing countries are willing to sell sugar to the USA (e.g. their domestic cost plus transport costs to the USA or the net price they would receive from selling to a different, non-quota, country). For any given quota of sugar imports, we can ask "what is the tariff on imported sugar such that, at that price, the US domestic quantity demanded for sugar would be the quota amount?" That is the "tariff equivalent" of the quantity-based border-based barrier to trade. In 1990 there were official USA government estimates of the tariff equivalent of sugar quotas for the late 1980s (USITC, 1990). Their empirical results were that in 1987 the "world price" of sugar (landed in the USA) was 18.5 cents/kilogram (14.8 c/k was the price fob in a Caribbean port and 3.7 c/k to ship it to the USA) and the US domestic price was 48.1 cents/kilogram and hence the price equivalent of the quota was 29.6 cents/kilogram or an *ad valorem* tariff equivalent of 160 percent. This also creates an estimate of the "quota rent" --the gain to a sugar producer of being allocated some of the existing quota. Suppose you were the Dominican Republic and could produce sugar in 1987 for 10 cents/kilogram at your port. If could sell it on the world market for 14.8 for a landed price of 14.8 cents versus the US price pf 48.1 less freight of 4.4 c/k you would be massively better off selling to the USA than to the world market or using it at home). Trade economists have often used the sugar quota in the USA as an example as the tariff equivalent as 160 percent is a massive price equivalent distortion.

Note that the price equivalent of the quota for the USA is the *lowest cost* supplier of (landed) sugar and that, if each country had a different cost of producing sugar and a different transport cost to the US market then the price equivalent *at the margin* would be the least cost producer but that, if they could not supply the entire US demand at undistorted prices then an estimate of the conceptual *average* price equivalent of the quota would have to add up the world supply curve to the US across the various suppliers. In practice, the USA allocated the quota across various producers of sugar based on political considerations as, if the country could receive the US domestic price there was a windfall gain to be allocated. Also, it is obvious the quota is not binding for countries whose production cost for sugar is higher than that of the USA.

In a recently published (but long ago completed) paper Claudio Montenegro, Michael Clemens and I estimate the price equivalent of the restrictions to labor mobility in the USA (Clemens, Montenegro, Pritchett 2019). If we think of immigration policy by analogy with trade policy the analogy is that there is a general ban on non-citizen labor working in the USA unless the person has a specific license to do so. These licenses come in the form of either general admission of immigrants authorized to live or work in the USA (e.g. those on a path to citizenship or with a 'green card') or a series of specific programs, like the H1-B visas for workers with specific skills, or provisions to allow for "work study" (e.g. *au pair*). The effects of this overall ban with selective licenses are too complex to study intervention by intervention and so we directly compare wages in the home and the US market, in two steps.

First, we use the combination of the US Census data, that has wages for all workers in the USA, their level of schooling, their country of birth and their age at arrival in the USA, and a collection of labor force surveys from around the world. That way we can compare the wages of worker in the USA and an "observational equivalent worker" in the migrant's home country. So we can estimate econometrically the relationship between wages and characteristics like education, sex, residence, sector of work, age. So we can compare the regression predicted wages of two individuals, both 35 year old males, both with 9 years of schooling, both working in the formal sector in an urban area, both born in Guatemala and both of whom received their schooling in Guatemala. The difference being that one is working in the USA and one is working in Guatemala. We use purchasing power parity exchange rates to produce a comparable consumption wage, which, if the immigrant spends any of their income in their home country (either through remittances or savings used on return) *understates* the consumption wage gap (and this effect is big).

This construction of the price differential of a specific kind of labor is again by exact analogy with the literature on international trade. If I want to estimate of the price equivalent of a quota (or complex set of non-tariff barriers) on steel I cannot just compare steel prices in the USA and steel prices in Japan—one has to be sure one is comparing likes to likes and compare the prices of as exact equivalent steel.

The second part of the calculation is trickier. Since people choose to move there is the real possibility of that the choice of moving across national borders is based on selection effects based on characteristics that affect wages in the home country and in the USA that are not observed. It is possible that the observational equivalent Guatemalan in the USA had more "gumption" or "drive" or "grit" than his Guatemalan based counter-part and hence this unobservable would have meant this person would have not been at the average of the wage distribution had he been in Guatemala and hence the comparison of average wages in the USA to average wages in Guatemala of observational equivalents may overstate the gains to either the marginal worker (the worker that would move with an incremental relaxation of constraints) or the typical worker (what would happen if a randomly selected worker were to move). I need to make three points about this, the third being actually what we did technically that I report.

First, in thinking about selection one wants to separate out the high skill, or even super-star, labor markets and the low/medium skill markets were are investigating. That is, suppose I were compare the wages/income of Argentine football (soccer) players in Spain to that of Argentine players in Argentina and adjusted the wages for a series of observables like age and even maybe some "objective" characteristics like height and speed in the 40 yard dash. Everyone would recognize that this calculation is going to be very hard and simple versions of it silly because one of those Argentine born Spanish league players is Lionel Messi, who is Lionel Messi because his "unobservables" (in an econometric regression sense of unobserved) are what makes him Lionel Messi. So, there is going to be a massive long right tail of earnings based on selection such that comparing average wages of Argentine players in Spain to Argentine players in Argentina will be

plagued with difficulties. Since nearly everyone reading this paper is in the far, far, positive tail on certain kinds of talent and ability (e.g. academic adeptness or "intelligence") and many operates in international settings and markets the these selection effects on wages and mobility on unobservables in markets for high-skill and super-start ability loom large on our radar screen.

But we are estimating the price equivalent of labor with less than a high school degree working the USA. As we will see, the average wages of these workers in the USA is around $10.50 dollars/hour (about $22,000 a year). A report by Brookings (2012) examined these workers using the US census data and found that low-skill immigrant workers are concentrated in certain industries and that, even within those industries are concentrated in certain tasks. For instance, they showed that immigrants are over-represented in the "accommodation" industry (over 30 percent of workers in the industry versus 16 percent economy wide) and that within the "accommodation" industry 60 percent of immigrants have less than a HS degree and that of the foreign born working in the "accommodation" industry over half (54.1 percent) are maids/cleaners, janitors/cleaners, cooks, or dining room attendants. Or, in the construction industry again 60 percent have less than a HS degree and over half are laborers, carpenters, painters, or roofers (and 25.6 percent are "laborers" versus only 10.9 percent of natives in construction are in that category). So, in framing your intuition of the impact of selection effects on our results of price equivalent of low skill labor think of motel maids, construction laborers and food service workers making on average 10$/hour in the USA, not the selection effects of Lionel Messi moving from Argentina to Spain or professors of economics moving from India to top US universities or of Vinod Khosla doing venture capital in Silicon Valley versus Bangalore. In those instances, we can all agree selection on econometric "unobservables" is likely the dominant factor in observed income differentials.

Second, I worry that with the current obsession (in the psychological clinical sense of obsession) with precision in identification, and the equation of "precision in identification" with "randomization," many economists are beyond missing the forest for the trees, they are missing the forest for the texture of the bark on the trees. Besides the technique below of Altonji adjusted lower bounds to accommodate selection effects I report next, we have, over the years tried at least a half a dozen ways to estimate the rough magnitude across countries of the selection effects. All of these methods produce estimates of the magnitude of selection effects centered below 25 percent (e.g. the ratio of observationally equivalent wages should be scaled back by about 25 percent to be the estimate of not just "observationally equivalent" workers but "equal productivity" clean of selection effect workers). For instance, as just one of these methods, we examine labor force surveys in sending countries that follow the same workers over time to examine the wages in early rounds of workers who then attrit from the domestic sample because they move abroad. This can provide a direct estimate of the selection of those who move abroad both on observables and on unobservables (are wages in the home market higher, conditional on observables, for those who subsequently move abroad). For the countries for which we have this data we find modest positive selection, but nothing like anything that would significantly reduce our estimates of price

equivalents as we find 3 to 5 to 10 fold wage differences (the forest) whereas selection could account for, say, 25 *percent* (the bark on the trees).

Third, Table 1 presents our basic results using the Altonji-Oster adjustment for selectivity to create an upper-bound estimate of what the wages of an equal productivity worker of those whose wages we observe in the USA would have been in their home country. We are able to estimate these quantities separately for each of 40 countries, that is, we make no assumptions that the wage profiles with respect to characteristics (e.g. returns to schooling) are the same across countries.

In line with assuming that the price equivalent of a border barrier is the price distortion of the *low-cost* supplier (the price equivalent of sugar quotas is conceptually not based on those countries to whom the quota is allocated, which is political, but to the low cost supplier in a non-distorted market) I show in Table 1 the countries with the ten largest price distortions and their relevant populations aged 15 to 49 (the group most likely to move for labor).

The price equivalent of border based restrictions to low skill labor mobility ranges from a 1500 percent to roughly 500 percent, or equivalently, the wages of low skill workers are a factor of 15 times (Yemen, Nigeria) to 5 times (India, Indonesia) higher in the USA than in the low cost potential suppliers. Figure 1 shows these same results as a supply curve, where we also allow for the fact that there will need to be a wage differential to induce movement and produce equivalent utility/well-being. (Offsetting this is that the wage differentials we report are adjusted for PPP on the assumption the mover consumes at US prices. If the migrant remits income or saves and spends on return then the *consumption wage* differentials are much, much higher than we report).

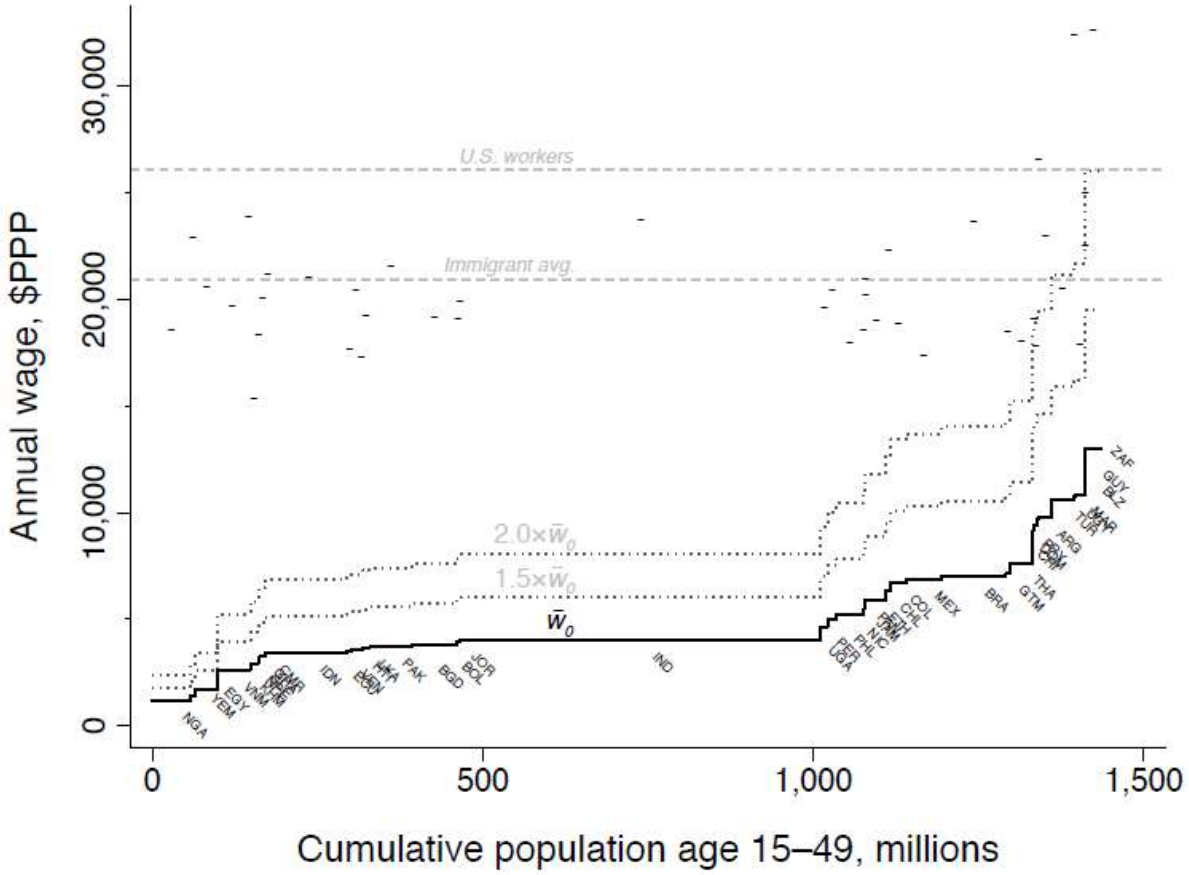
Table 1. Estimates of the price equivalent of the USA barriers to low skill labor, ten largest distortion countries, with population 15-49

Country	Annual income of low skill worker in the US, $/hour in 2000	Upper bound (using Altonji-Oster adjustment for selectivity) estimate of the annual wage in home country (adjusted for PPP) of the same, equal productivity, worker	Gain from labor mobility for a low skill worker	Price equivalent (percent distortion)	Pop'l, 15-49, millions
Yemen	$23,042	$1,408	$21,634	1537%	7.60
Nigeria	$18,689	$1,186	$17,503	1476%	57.01
Egypt	$20,739	$1,712	$19,028	1112%	33.91
Cambodia	$24,026	$2,626	$21,401	815%	5.91
Vietnam	$19,820	$2,624	$17,196	655%	43.73
Cameroon	$21,348	$3,395	$17,952	529%	7.11
Sierra Leone	$18,459	$2,944	$15,514	527%	1.86
Ghana	$20,179	$3,238	$16,941	523%	9.08
Indonesia	$21,194	$3,423	$17,771	519%	117.26
India	$23,846	$4,021	$19,825	493%	544.70
Unweighted average (total for population) of 10 countries with largest distortion	$21,134	$2,658	$18,476		828.16
10 largest population countries, weighted average (total pop')	$20,266	$4,286	$15,981	373%	1,156
Population weighted average, 40 countries (total pop'l)	$21,855	$4,740	$17,115	361%	1,435
Per hour wage (assuming 2080 annual hours), population weighted.	$10.51	$2.28	$8.23		

Source: Author's calculations based on results from Clemens, Montenegro, Pritchett (2019).

The US census data allows us to handle the challenges of adjusting for the selection of migrants on both observables (e.g. years of schooling) and unobservables (e.g. grit) to estimate the "place premium" in wages of the USA over many other countries. But there is no reason to believe that roughly the place premium for low/medium skill labor is not roughly the same for other high wage OECD countries (e.g. Europe, Japan, Australia, Canada, New Zealand).

Figure 1. The global supply curve of low skill labor (at 50 or 100 percent premia of home over migration) to the USA

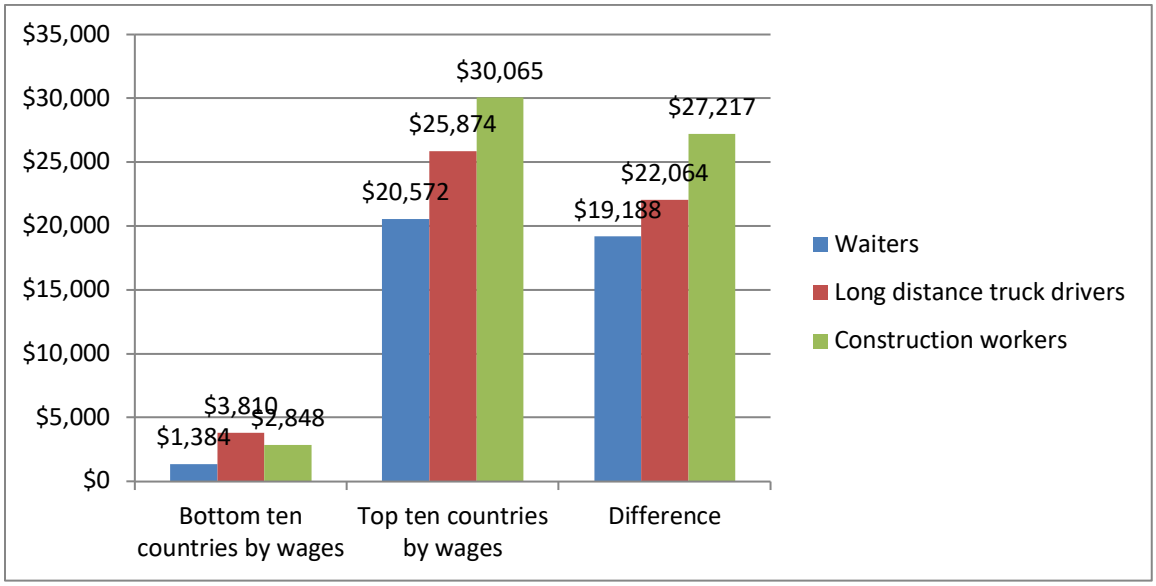


Source: Clemens, Montenegro, and Pritchett 2019.

We can cross-check the CMP (2019) results in other ways. Using data on occupations, for instance, we can compare wages of people in the same low to medium skill occupations between high (top ten) and low (bottom ten) wage countries. Figure 2 shows the difference in (PPP adjusted) annualized (hourly wages times 2080 hours for all countries) incomes for three occupational categories: waiters, construction workers (across all types from laborers to carpenters, etc.) and long-distance truck drivers. The absolute gap is larger the larger the skill premium within the countries (e.g. construction versus waiters). The agreement between these calculations, from a completely different data set, for averages of top and bottom ten (of those

reporting) countries, for a different method of accounting for differences in skill and selection, is striking: PPP$18,476 for USA low skilled versus PPP$19,188, price equivalent of 1486%, for waiters top to bottom ten wage countries.

Figure 2. Wage differentials (in PPP) across top and bottom 10 (reporting) countries by occupation



Source: Author's calculations with data from Occupational Wages around the World (OWW) data (Oostendorp 2012).

My claim is that these are not just the largest price distortions in the *current* world economy, which they are, by orders of magnitude, but may be among the high policy intervention induced price distortions ever observed, in both height and base, in the history of mankind.

3.2. Historical wage differentials

The economic historian, Jeffrey Williamson, has assembled data on real wages around the world at the beginning of the 20th century, when the UK was the world's leading economy (Williamson 1998). These wage differentials are of the same rough size as the wage differentials we find for countries versus the USA today. While wages were high in some South American settings (e.g. Mexico, Argentina) there is a range of then (and now) poor countries that had wage ratios of around 5 to 5.6 (e.g. India, Burma, Indonesia, (Southeast) Brazil) which is the level we see in the top ten country comparisons with the USA.

Figure 3. Wage differentials are as high today as at the turn of the century

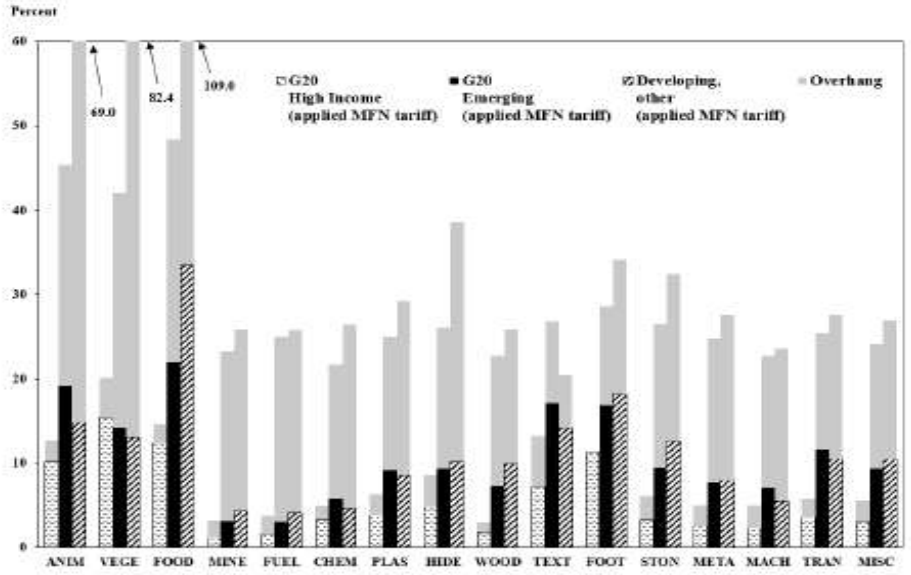
Source: Based on data from Williamson 1998.

3.3. Price distortions in goods markets

Figure 4, taken from Brown and Crowley (2016) where it is Figure 2, shows a standard presentation of current (2013) barriers from tariffs, which shows the applied rates and also the "bound" tariff rates, which, particularly for developing countries, are often much higher than the tariff rates actually applied. Particularly when examining the results for the G20 high income countries the average applied rates across all sectors are less always than 20 percent (with their highest values for agriculture) and mostly well less than 10 percent. The average explicit tariff based distortions to the movement of manufactured goods are in the USA and the EU are currently less than 5 percent, which is a factor of 100 (two orders of magnitude) smaller than the 500 percent price equivalent barrier to the movement of low skill labor.

Figure 4. Barriers to trade are orders of magnitude smaller than differentials in labor prices

Figure 2: Average Applied MFN Tariffs in 2013 and Tariff Bindings, by Industry and Country Group

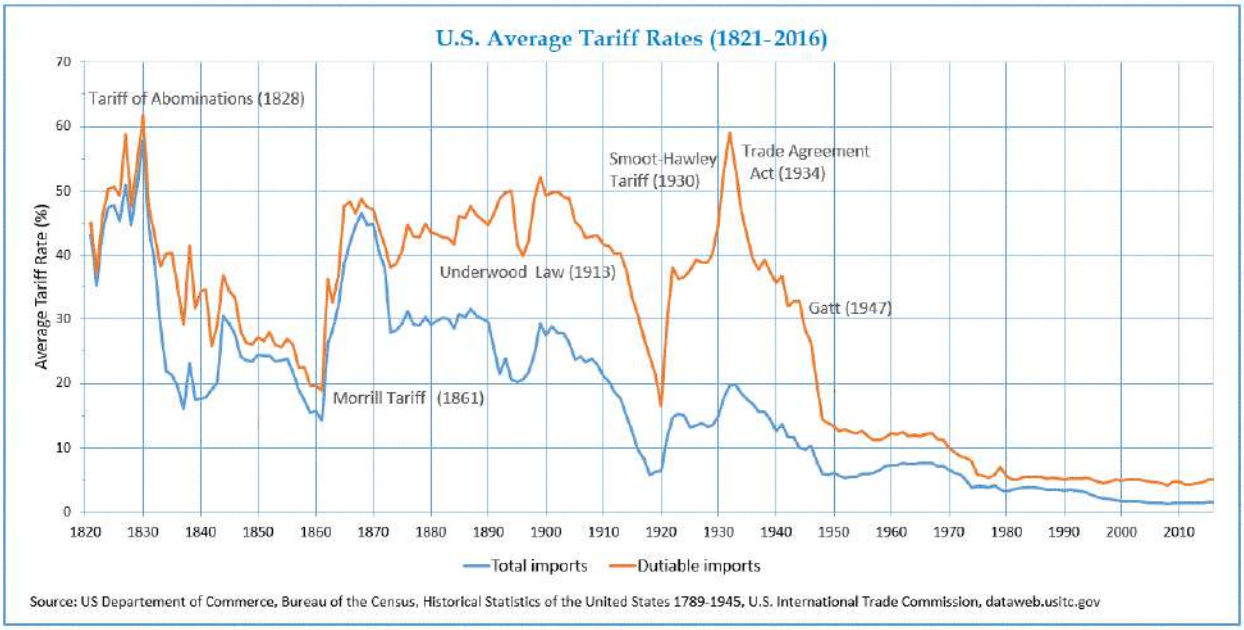


Source: Constructed by the authors from tariff data at the HS-06 level from the WTO and UNCTAD/TRAINS. Tariff 'overhang' (or water) defined as the difference between the country's tariff binding legal commitment and its applied MFN rate. Country groupings based on Table 1.

Source: Brown and Crowley (2016).

Figure 5 shows the evolution of tariffs in the USA on both total imports and on dutiable imports. The *highest* tariff rates have ever been on dutiable imports in the USA is around 60 percent, which is around 1828 and in the Great Depression, although following steadily after both of these spikes. The USA did maintain from the Civil War to the turn of the 20th century a "high tariff" regime, but these tariff rates are *lower* than the *smallest* wage differential observed in the CMP estimates (the Dominican Republic differential is around 90 percent). Moreover, the *highest* tariffs have been on US history are (roughly) *an order of magnitude* smaller than current observed wage differentials (60 percent versus 500 percent).

Figure 5. Average tariffs in the USA have historically never been higher than 60 percent



Source: https://en.wikipedia.org/wiki/Tariff_in_United_States_history

4. The second big distortion of the cost of labor, particularly of jobs

The second issue is that a pressing issue for developing country governments everywhere, for economic, social, and political reasons, is providing adequate employment for their populations, which expresses itself particularly in the issue of jobs for youth. In this section I want to argue that a variety of policies around taxes and benefits in industrial countries make jobs expensive and hence create a demand for both *labor displacing* innovation and R&D that displaces labor with machines (and other technology) but also *labor shifting from jobs to non-job work.* So, on top of making low and unskilled labor expensive by border-based barriers governments add to the massive distortion additional distortions that make jobs expensive.

4.1. Is there something special about jobs versus labor?

The natural instinct for macro economists is to focus on aggregated factors like labor, capital, and technology. This tends to tread the demand and supply of labor services in ways that make no distinction between what one might mean by "jobs" and other forms of employment like casual employment on a day to day basis or even self-employment. In some ways this is a useful corrective as one wants to emphasize that people do make choices about their employment and may choose between allocating their labor between self-employment, employment in the informal sector and a formal sector job. Maloney (1999, 2003) makes the case that the traditional view of "dualistic" and segmented labor market in which the informal sector workers are disadvantaged is not borne out by evidence about labor market dynamics and transitions. Blattman and Dercon (2017) report a recent experiment in Ethiopia which suggests that, with support, people prefer entrepreneurial self-employment to available factory work.

However, I want to point out two ways that "jobs" are different from other work and hence may create an social externality to "jobs" over "employment." This externality, however, can lead to driving a wedge between the cost of labor in jobs and in non-jobs, which itself promotes R&D that displaces jobs.

Jensen (2019) argues that the historical rise and maintenance of the high rates of tax collection to GDP observed in richer countries are essentially supported by the rise of employment in formal sector jobs. The shift from self-employment and small scale (informal) employment into jobs makes the administration and collection of taxes on labor much lower and hence facilitates the ability of governments to raise tax take. To the extent these taxes reasonably effectively finance the provision of public goods this reduction in the collection costs of taxes can be welfare improving (although whether, in an given governance conditions taxes are a "price of civilization" or merely "tribute" is an open question (Pritchett and Aiyar 2015)).

The Jensen (2019) argument about the role of the shift of labor into jobs in facilitating the rise of taxation should be seen as a piece with the landmark work of Lindert (2004) documenting the rise of government taxation and spending in the now industrialized world since the 18th century. The thrust of Lindert's work is that the main use of additional taxation and hence the main proximate explanation of the rise of government spending to GDP was spending in the "social" sectors, by which programs of "social insurance"—health insurance, unemployment insurance, old age insurance (social security)—were the main drivers (with education as an additional element of social spending, but typically much smaller). This linkage between social insurance and labor taxation is important empirically and analytically in the USA. In the current structure of federal taxation in the USA nearly half of earners pay essentially no federal income tax at all. In 2011 the bottom 44.8 percent of returns filed paid only 1.4 percent of the federal income tax collected[1]. But this is not that these workers are untaxed as they pay taxes for social security and Medicare (insurance for the elderly) at a rate of 15.3 percent (combined employee and employer tax)—which is also the tax on self-employment income.

Summers (1989) outlines the simple economics of alternative approaches to providing some benefit: mandated benefits for employers versus general taxation and public provision. He shows that in a variety of situations mandated benefits are to be preferred as they induce less distortions precisely because mandated benefits tend to be absorbed into wages and hence created only a distortion on the *difference* between the employer cost of the mandated benefit and the valuation to the employee of the benefit. In instances in which the employer can obtain a lower cost than the employee, perhaps because of economies of scale or because, for insurance products, the employer providers a "natural" mechanism for pooling that avoids the adverse selection problems that plague insurance markets, the distortionary impact of mandated benefits can be zero. Empirical studies of a variety of mandated benefits find that mandated benefits pass substantially

[1] Own calculations with 2011 tax year spreadsheet downloaded from https://www.irs.gov/statistics/soi-tax-stats-individual-income-tax-rates-and-tax-shares#_pagi.

into reductions in cash wages and hence do not deter employment (e.g. Gruber 1990 for maternity benefits, Gruber and Krueger 1990 for workmen's compensation insurance).

Of course, the major way in which the superiority of mandated benefits over labor taxation plus public provision in not displacing labor (by not changing its effective price to employers) fails is through either wage or labor market rigidities. Wage rigidities, for instance, like minimum cash wages make it impossible for the employer costs of mandated benefits to be passed into wage reductions and hence it does raise the cost of labor. Alternatively, if benefits are structured so they are a fixed cost per worker then the corresponding cash wage component of compensation reduction has to be larger for lower wage than higher wage employees. Alternatively, the valuation at the margin of mandated benefits may be lower for lower wage than higher wage employers (and obviously if this is a fixed benefit across all wages this is even likelier to be true).

For all these reasons, both tax and mandated benefits, the cost of low skilled labor in formal sector jobs may exceed the private revenue marginal product to firms—precisely because governments and societies are attempting to take advantage of the existence of formal sector jobs as a low cost mechanism for tax collection and of providing a variety of social insurance benefits. This created incentives for firms to push labor out of a job's relationship, both into mechanization through technology and, even when they need and want the labor, out of jobs into non-jobs modes of labor (e.g. contracting and "in-sourcing" customer labor).

4.2. Shifting work out of jobs

The "future of work" and the "future of jobs" are not at all the same thing. Figure 6 makes the distinctions among four types of interaction between "technology" and "jobs." I want to make in particular the key distinction between "labor shifting" and "labor saving" technological innovations. "Labor shifting" technological innovations don't necessarily use technology or innovation to reduce the total amount of labor but rather to shift the employment and compensation status under which the work was done.

Three starting examples, appropriate for a paper which was first presented at a conference to which I traveled from London to Kuwait, come from the travel industry.

First, take automated check-in, both on-line and at kiosks at the airport. Is this a "labor saving" or "labor shifting" innovation? While it certainly is intended to reduce the *paid employment in jobs* it is not at all obvious that the total labor, including mine as a traveler, is reduced. That is, if I, as a traveling customer am carrying out exactly the same tasks in exactly the same total time as it would have taken an employee with a job of the airline (or contracted firm) to do then this use of capital and ICT that is the self-check-in kiosk is *labor shifting* from job to non-job.

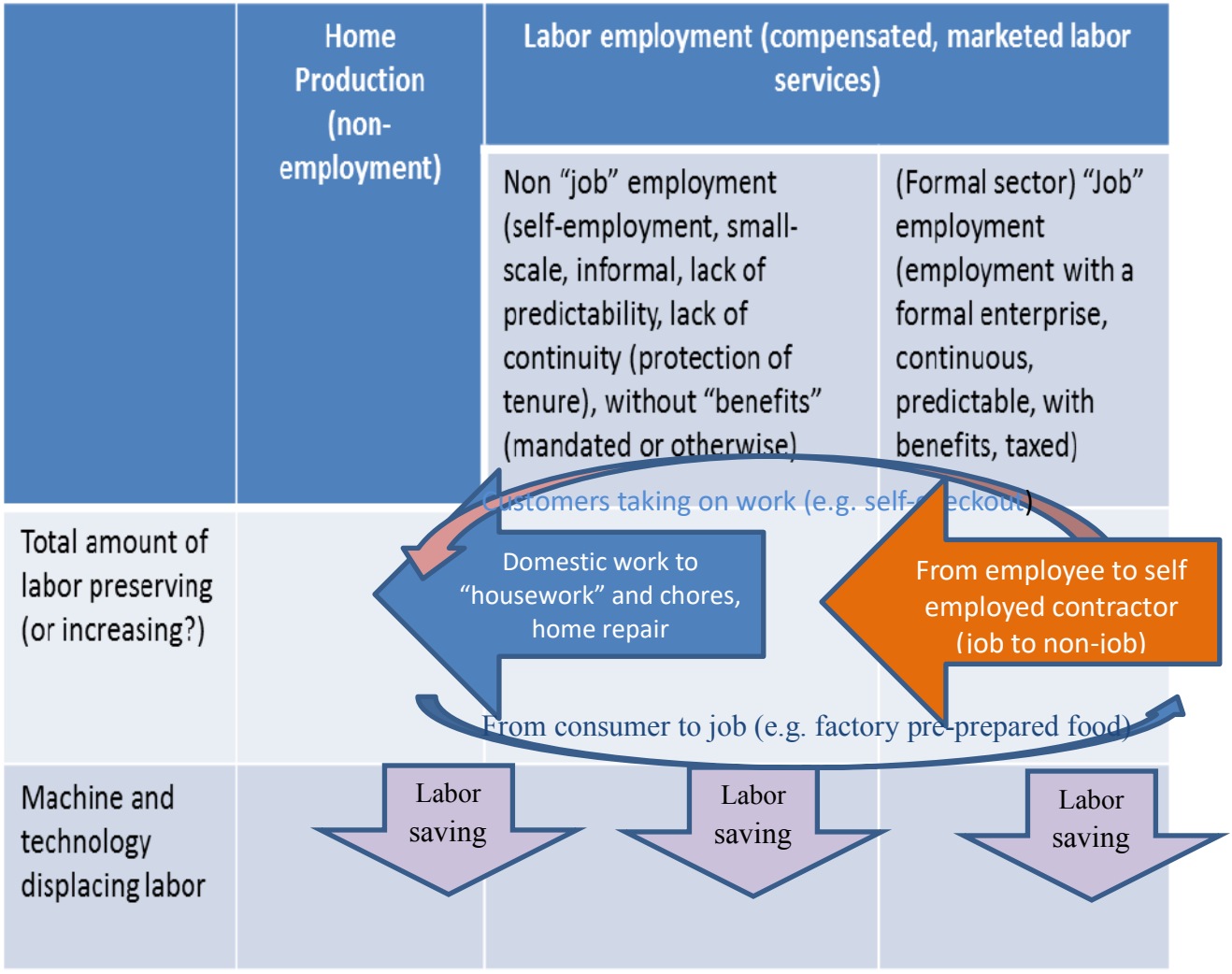
Second, in order to book the travel from London to Kuwait I went on-line and searched across possible flight times and airlines and booked and paid for my own travel. I am old enough to remember people who had jobs as "travel agents" who would do this work for me. Perhaps there has been some amount of net labor reduction but I do know that I spend much more of my time

considering alternative routes and prices than I did 30 years ago as ICT has allowed labor to be *shifted* from people with a job to me.

Third, and I give this example just to show how subtle and yet pervasive labor shifting innovation has been, are the wheels on my suitcase. Thirty years ago, when I traveled from the USA to foreign destinations I would load my suitcases in a cab. At the departing airport a porter would greet the cab and transport the luggage from cab to check-in counter, then baggage handlers would get the suitcase on the lane, at the destination airport baggage handlers would get the suitcase back to me, then another porter would get my suitcase to another taxi to a hotel where another porter would take my suitcase to my room. Today, I do all this labor myself due to the technological innovation of wheeled suitcases. For nearly all trips I pack lightly enough I have one wheeled suitcase and one wheeled briefcase. So I get my luggage myself from taxi to check-out, a reallocation of work from job (or employment)) to me, a carry the luggage through security to the plane, a reallocation of work from baggage handlers to me, I arrive with my luggage, a reallocation of work form baggage handlers to me, I roll my luggage through the arriving airport to a taxi (reallocation of work from porters to me), arrive at a hotel and often wheel the luggage to check-in and to my room (reallocation of work from baggage porter/bell-hops to me).

This last example brings up a point I will return to, which is that while, at the relative price of my labor in the USA to the total cost of a job for a person in the USA it makes tons and tons of sense to shift labor from jobs to me via the technological innovation of wheeled luggage, when I arrive in poor countries with this technology it makes no economic sense at all. Every time I wheel my luggage past the waiting porters in poor countries, I think that I would have employed them but with wheels it made no sense at essentially any price. I, perhaps falsely, wheel my luggage past the older airport porters and see them eyeing the technological innovation of wheeled luggage coming from rich countries knowing it is taking food off their children's tables.

Figure 6. Labor shifting and labor reducing technological innovations



Source: Author.

Using this classification there are five distinct phenomena, which of course all may blend into each other and these are not discrete categories, and I try and provide a paradigm instance for each.

First, there has been a massive shift of work from ***employment*** **(both jobs but also non-job) to** ***home production***, with many examples.

The displacement of "domestic help" with "housework" which is a movement from "non-job employment" to "home production." This is an under-discussed phenomenon, in spite of its size. Stigler (1946) documents that in the USA, even as late as 1940, there were more people employed as "domestic servants" that those employed in the railroad, coal mining, and automobile industries *combined.*

Within this shift there is some displacement of "labor" for "machines and technology" within those same services. So, the advent of washing machines, vacuum cleaners, dish-washing machines was

an increase in capital/technology reducing labor as a portion of value added in laundering clothes, which to some (very large?) extent was driven by a simultaneous shift from employment to non-employment as decline in the number of "domestic servants" shifted labor to unpaid household labor (mostly, given the socially (and legally) enforced gender division of labor) from paid women (in Stigler's data 92 percent of all "domestic servants" in 1940 were female) to unpaid female labor within the household. In *More Work for Mother: The Ironies of Household Technology from Open Hearth to Microwave* Cowan (1985) argues that in the USA modern women spend about the same amount of time on household chores as did colonial women. The array of household technologies—dishwashers, vacuum cleaners, irons, etc.—were not in fact "labor saving" devices but (a) labor shifting devices from men and children onto women and from employed women to unpaid family labor and (b) devices that created rising expectations of what the gendered role of "housewife" was expected to produce, rather than a source of reduced work for women.

The same shift is evident in other domains, like yard work and home repair in which there is a massive amount of work done (e.g. mowing lawns, removing snow, raking years) by American households which a bi-furcated market in which upper income households create employment by hiring these services in (mostly from "non-job" sources) while "middle class" households combine machines and technology with non-employment labor. So the lawn mower, while a "labor reducing" machine is also a technology to shift labor from employment to non-employment labor.

The modern American chain "hardware" store, like Home Depot or Lowe's, are a testament to the massive shifts in shifting services like "home improvement" or "home repair" from employment to DIY. Rather than exclusively or even primarily supplying inputs to professionals (e.g. plumbers, carpenters, painters, gardeners) the design and products have been modified to make it less skilled so that home production can displace employment.

Second, there has been a similar shift from **"jobs" to "non-compensated work."** The most obvious example is the recent, accelerating, expansion in the USA in retail self-checkout. This is *not* primarily a shift from labor to machine/technology but the use of a machine/technology to shift labor from jobs and employees of companies to customers. The total amount of time spent ringing up groceries isn't necessarily reduced by having complete unpaid amateurs like myself ring up my own groceries at Walmart and decide what type of apple I have picked up or, in a double whammy of displacing employment, ring up my DIY purchases at Home Depot. Similarly, with on-line and machine check-in for flights, this is making me do work that formerly airline employees did. Since there is probably some degree of specialization and some degree of a learning curve it probably takes *more* total work done to have customers ring up their own purchases. But the company has shifted from employment of people they have a long-term contractual relationships with (jobs) to uncompensated labor. Of course, with improvements in technology that lead to cheap capital firms can provide enough machines so that queueing time for customers is reduced and hence we are happy to be part time employees rather than stand in line. But best for customers of course would be more employees of the company so that we neither had to wait in a queue nor become an involuntary part time worker.

Pushing of labor from employee to customer has been perfected by firms like IKEA, who has become the world's largest retailer of furniture by designing furniture so that the assembly work is done as home production by the customer and not by employees of IKEA. I don't want to over-extrapolate from my own experience, but I am pretty sure that I assemble IKEA bookcases much, much, slower than would someone who had done it even a few times. So, IKEA furniture might actually be total work hour content *increasing*

Third, there is also a shift in the reverse direction from **home/domestic work to employment and to jobs**. A paradigm example is the shift in this category of household labor (home production) to jobs there is, for instance, prepared foods, which are a continuum of the degree of processing from raw ingredients to final served meal. No one who has shopped for food in a US grocery store versus a store in India (or food markets in India) can fail to be impressed with the difference in value added. In a US store "raw ingredients" (e.g. flour, rice, vegetables, meat) are a rarity. Much of the value added of food preparation is now done by large corporations.

Fourth, there has also been recent moves in the USA from **"jobs" to non-job employment**, the paradigm case being firms like Uber and Lyft which have shifted taxi services from a mix of employees and self-employed to exclusively a non-employee relationship. The number of people making some income from being an Uber driver is about 100 times larger than the number of Uber employees.

At least the monetized versions of the so-called "sharing economy" are generally a shift from services provided by firms using employees to services that do not involve jobs. For instance, Airbnb, which is still a relatively small total supplier of accommodation, shifts services like cleaning the rooms from employees of hotels (or firms with jobs that contract to hotels) presumably to a contract between a Airbnb provider (or to home production).

Fifth, in all of these categories (and across them) there has been some shift from labor to machines/technology overall. But I wanted to emphasize that many uses of machines and technology are *not* to reduce the total amount of labor but to shift that labor from jobs to non-job employment and from compensated employment to non-employment labor.

4.3.1. Movement of jobs in "tradable" activities but hard-core non-tradables

For activities of the production process that can be pushed abroad this wage differential, to the extent it is not fully a (persistent) productivity differential, has of course created the massive incentives for (parts of the) production process in manufacturing goods to be re-located abroad—as capital and know-how are moved abroad towards available labor, rather than labor brought towards capital and know-how.

It is worth pointing out that, in contrast to what has been repeated thousands of times, this is *not* (not! not!!) the consequence of "globalization." So, the impact of "globalization" in moving US (or other advanced country) jobs abroad is *not* a consequence of "globalization" per se, it may be a consequence of the *differential* lack of border-based barriers to trade in goods versus mobility of

labor. With anything like what could be called a true globalization, that included *all* markets—including the market for labor--it may well be the populations of the OECD countries, and jobs in manufacturing in those countries, would have *expanded* massively. The post-World War II global order has *not* (not! Not!!) been a "globalization" (in the way, that, say, the Atlantic economy (at least)) was globalized prior to World War I in that all markets—commodities, capital and goods—were able to move freely) (Pritchett 2009). The post-war (and still current) order is a rise of many more states (the "proliferation of sovereigns" (Braun et al 2004) and much *more* control of labor mobility.

It is worth pointing out that if there are persistent spatial differences in productivity, for instance, if there are agglomeration economies or other place based sources of persistent productivity (e.g. access to a port), then in an integrated, barrier-less world, all factors, including labor, will move towards productivity (until spatial diseconomies, like increasing land rents or congestion costs, equilibrate)[2]. Much of the observed "convergence" in GDP per capita across US states, for instance, is driven by the fact that California is a "slow growing" state and Mississippi is a "fast growing" state in GDP *per capita* while of course in *population* or *total* GDP California grew massively faster than Mississippi. Within many large, spatially integrated countries the main regional differentials are in population growth, not economic growth (Pritchett 2004).

Perhaps the most important thing we have learned from 50 years of experience and data about the processes of economic growth is that, unlike what might have been expected from a crude extension of the Solow-Swan model to explain international differences, TFP *has not converged* (Pritchett 2018). So, one might have looked at the Solow model and expected that (a) TFP or A, being a "public good" of "knowledge" of codifiable, replicable, technical knowledge, would converge very rapidly (except for barriers of intellectually property, which are time-limited in any case) and hence (b) this would produce very high marginal product of capital and capital/labor ratios were low in poorer countries and hence (c) the main constraint on growth in poorer countries would be the speed with which capital could be created, limited by available domestic savings the ability to attract international savings. This is almost the complete opposite of what has happened as, by some measures, what has converged the *slowest* is TFP as even basic technologies have not spread (Comin and Mestieri (2018)) so that MPK is already equalized (Casselli and Feyrer 2007) and hence there are not pressures for capital to flow to poor countries but rather labor to flow to rich countries, which is blocked.

The advance of digital and ICT technology has also allowed various elements of the "service" industry production chain to be moved abroad, as, for instance, call centers have arisen around the world to both handle simple service calls and telemarketing of various types. But a very large (and increasing) share of total labor activities in rich countries are "hard core" non-tradables, like

[2] See for instance Easterly (2004) on inequality in "factor world versus productivity world" internationally or works on spatial economics like Fujita, Krugman, Venables (1999).

transportation and room cleaning and yardwork. These services require physical, spatial, presence (unlike some services, like those done by call centers than can be offshored).

The structure of taxation of labor and of mandated benefits have created incentives for firms in rich countries to simultaneously (a) push labor to lower cost places, which has been a long-standing trend, with waves from Japan then to Korea and Taiwan then to Indonesia, Malaysia and then to the more recent and more information technology enabled (a la Baldwin 2016) shifts to China and Vietnam, (b) adopt machines and technology to shift out of labor, and (c) use technology to shift labor from "jobs" to "non-job" use.

5. Implications for jobs: USA and elsewhere

Timmer and Williamson (1997) propose that the shift from more open labor flows (at least within the "Atlantic economy" between Europe and the Areas of Recent Settlement) to restrictive barriers to migration happened at roughly the same time in a number of countries (e.g. USA, Brazil, Argentina) was not just "xenophobia" but (also) in part the simple logic of the previous migrations and the median voter theorem producing a politics in which the median voter saw him/herself as a close substitute to arriving migrants and hence voted to restrict the supply of this labor in the hopes this would increase their wages. However, by creating forces that allowed for massive distortions in wages across countries, this created pressures for labor substituting shifts in everything from housework to factories to wheels on luggage.

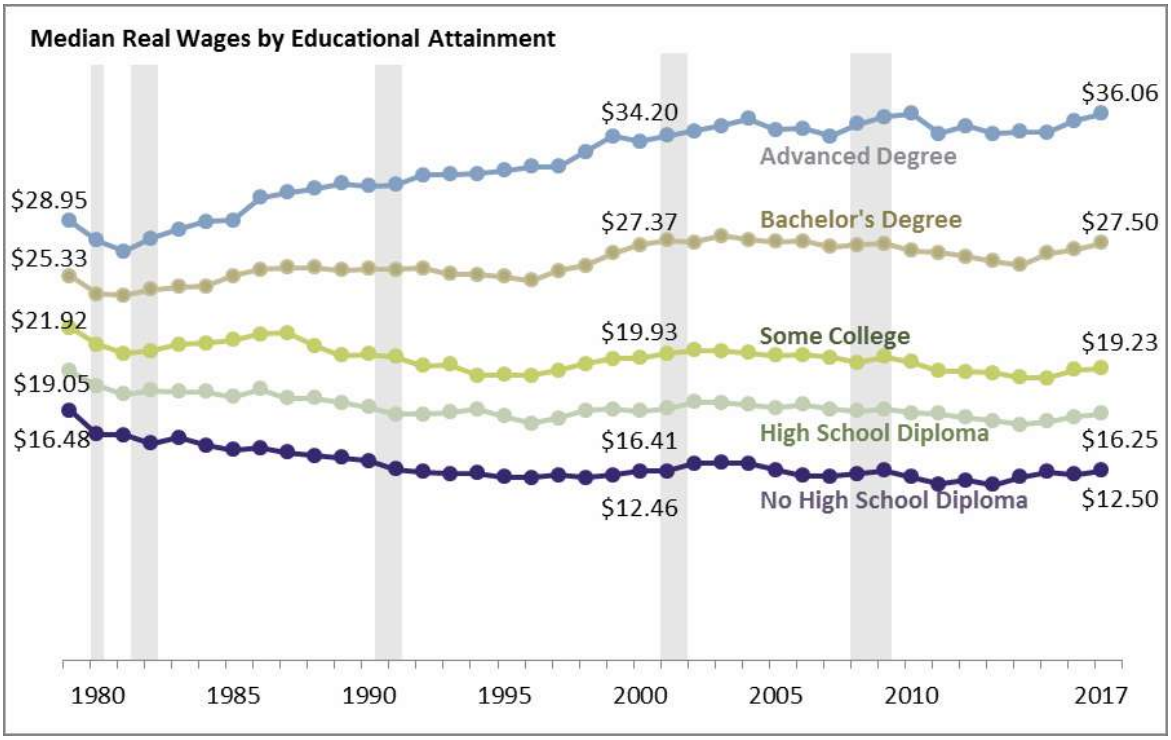
5.1. The US labor market

The last forty years have not been good for low to medium skill labor in the USA. Figure 7 shows the evolution of median of real wages in the USA for workers with various education levels from 1979 to 2017 (Donovan and Bradley 2018). The real wages of all education levels less than a college degree have fallen, and the less the education the larger the fall (e.g. 24.1% for those with less than a H.S. degree, 14.7% for H.S. degree, and 12.3% for those with some college). A major endeavor for labor economics has been to try and explain the facts about the evolution of employment and wages and parse out the causes of the absolute and relative wages shifts over time given changes in technology, trade and globalization, and migration in the USA over this period. Explaining these shifts in terms of supply and demand is made challenging by the fact that, over this same period there was a substantial expansion in education levels and hence a substantial expansion in the (relative) supply of skilled versus unskilled labor force. Moreover, and one presumes in part in response to the shifting wages, there was declining labor force participation rates among males that was larger for less skilled than more skilled labor such that labor force participation among prime age males with HS or less education had fallen to 83 percent in 2014 (from over 96 percent in 1964).[3] Therefore the supply of low skill labor force would suggest, all else equal, a *rise* in the relative price of unskilled labor (as it was scarcer) rather than the observed fall in (absolute) and relative wages. Hence much of the research is focused on what the "all else"

[3] https://voxeu.org/article/long-term-decline-us-prime-age-male-labour-force-participation-and-policies-address-it

is that clearly was not equal and whatever that "all else" is it clearly reduced the relative demand for low to medium skill labor substantially.

Figure 7. Median real wages of low to medium skill workers have fallen substantially from 1979 to 2017



Source: Donovan and Bradley (2018)

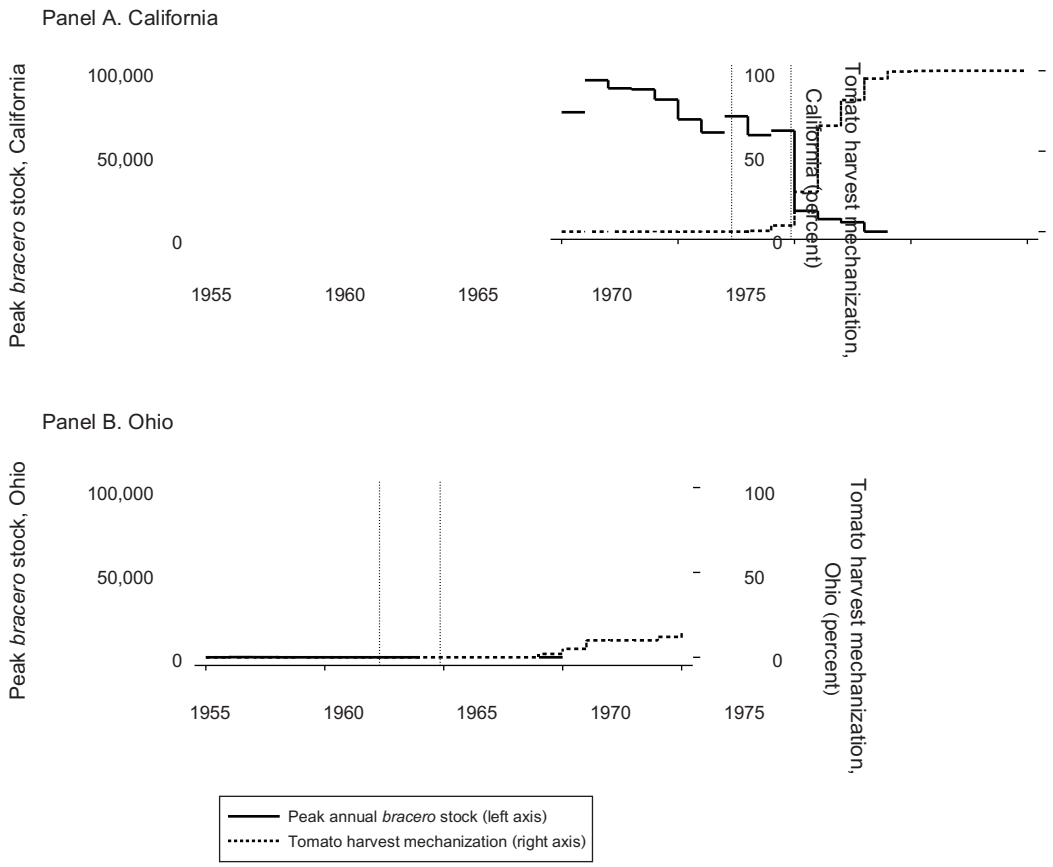
While globalization played some role in these relative wage shifts, particularly in the later periods as the China effect became large (which did not happen until well after 1979) there is a widespread consensus (that technological shifts that reduced the demand for less skilled labor played a large role. What Acemoglu and Autor (2011) refer to the "canonical model" has factor augmenting technical change that affect either low or high skill labor. They point out that, while this model has had some success in explaining some features of the evolution of relative wages in the USA on the basis of technical change, it leaves many features of the labor market unexplained. Autor and Dorn (2013) argue that the canonical model cannot explain the "polarization" in the US labor market in which both employment and wages are actually expanding at the lowest end of the wage/skill distribution—labor intensive services—faster than in the middle of the wage/skill distribution.

The only point I wish to make here is that if the purpose of the US policy of maintaining tight restrictions on labor market flows that created massive wage differentials between equal intrinsic productivity workers was to create an economy with high and rising wages and (near) universal labor force participation, particularly for the "working class", in order to create a means of delivering high well-being (in part by using mandated benefits to effectively delivering a variety

of "social insurance" like benefits) then these goals are factually not being met. The key debate is whether this is due to a set of technological shifts that were entirely exogenous (e.g. Moore's law just happened to happen and Moore's law just happened to enable high skill augmenting and medium skill displacing changes) or whether the policy of the very high cost of jobs in the USA itself was responsible for the endogenous direction of R&D to displace jobs and that this force of endogenous technological development has been more powerful than imagined.

One recent piece of evidence on this question uses the US elimination of the *Bracero* program in the early 1960s, which had allowed for Mexican seasonal agricultural labor. Clemens, Lewis and Postel (2018) use the fact that all of this labor was used in states bordering Mexico and hence can compare the job market evolution of *Bracero* labor using and non-using states following the elimination of the program to examine impact. They find no impact on the elimination of the *Bracero* program on agricultural employment or wages for agricultural workers in the affected states. They find that the explanation for the lack of positive impact on domestic workers was that farms either shifted technology or shifted product mix in response to the change in labor availability. Figure 8 (their Figure 5) shows the share of tomatoes harvested by machines moving from essentially zero to 100 percent beginning precisely the year in which the *Bracero* program ended (in contrast to Ohio, that have never used immigrant labor and did not adopt machines).

Figure 8: Massive adoption of machines to harvest tomatoes in California in response to a policy induced reduction in the availability of seasonal immigrant labor



Notes: Left axis, total *braceros* working in state in the peak month of each year almost always October . Mechanization means that tomatoes were harvested with the Blackwelder tomato harvester, reported by Vandermeer 1986 . Vertical dotted lines show the beginning March 1962 and completion December 1964 of exclusion. There were 74 and 64 *braceros* in Ohio in the peak month 1956 and 1957, respectively, and zero in all other years.

Source: Clemens, Lewis and Postel (2018), Figure 5.

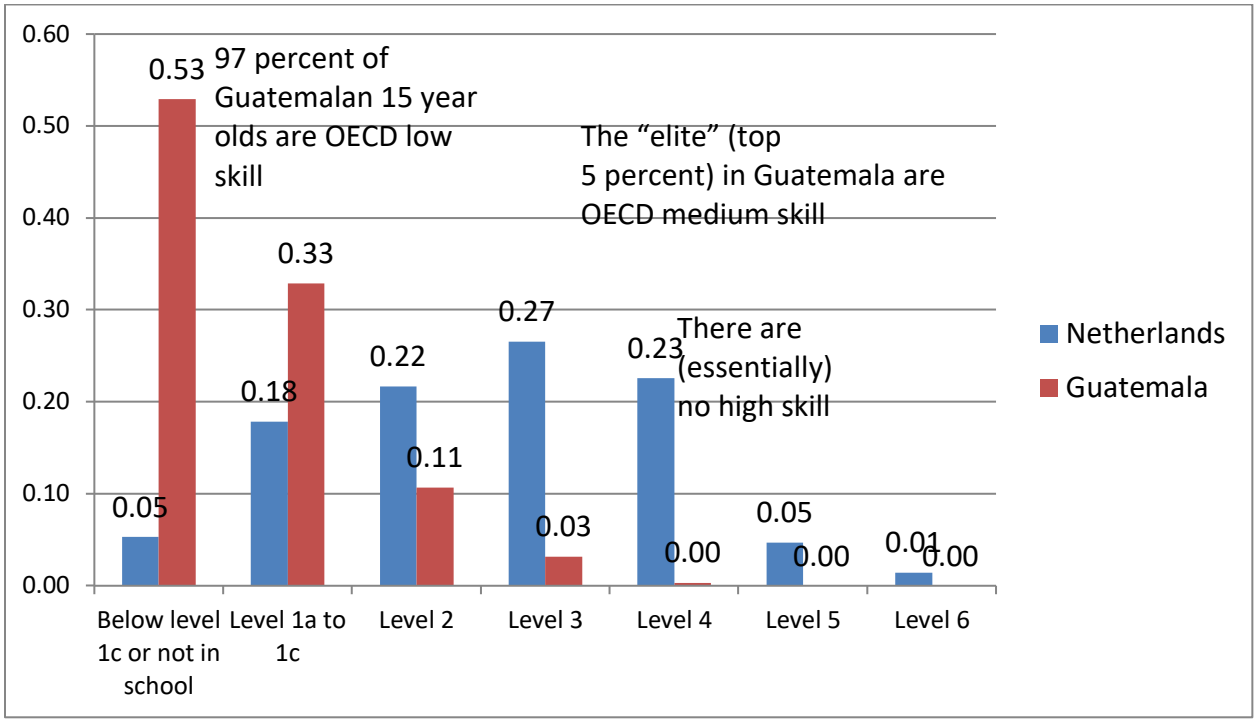
5.2. The impact of technology on the rest of the world

I am by training and inclination a development economist, not an economist who studies the US labor market. My concern is that the USA (and other rich industrial countries) are, through their policies that distort the cost of jobs to large and medium sized firms, making the hardest problem facing developing countries harder.

The hardest job facing developing countries is finding high wage employment, and preferably, given their positive potential externalities, "jobs" for their labor force. This is a hard job because, on the global scale of "skill" the labor force in most developing countries is very, very low skill by industrial country standards. This is important as the levels of "schooling" (which are rising very fast) can misleading about the level of skills. An OECD program assessed adult functional literacy and included in the study the city of Jakarta. Adults in Jakarta with a *tertiary*

education has a lower level of functional literacy than Danes who were high school dropouts. The OECD PISA program, which has under-represented developing countries, expanded into five new poorer countries through PISA-D. Figure 9 shows the difference in skill levels on literacy between the Netherlands (a not atypical OECD country) and Guatemala (a not atypical developing country). The Netherlands I am sure worries about the employability of its youth that have low skills—and roughly 45 percent of its youth (aged 15) have level 2 or below literacy competency. But the Netherlands also has 29 percent of its population at high skill (levels 4,5 or 6), which is 64,000 per cohort entering the labor market at high skill. But in Guatemala *97 percent* of 15-year olds are level 2 or below. And there is only .33 percent at high skill so that Guatemala has only around 1,300 people per year coming into the labor market at even a modest definition of global skills.

Figure 9. The fraction of the developing country youth entering the labor market who are globally low skill is very high



Source: Author's calculations with PISA-D data.

The hard question, on which I will not be able to make even a dent in this present paper, is the extent to which the technological choices create the task of job creation in developing countries harder. Some might argue that the technological innovations at distorted prices in rich countries have no impact on development because, if these technologies are not economically viable at the actual prices in developing countries then they won't be adopted and while labor choices might be affected in rich countries this does not affect developing countries so there is no negative externality. I think this is wrong for three reasons.

Let me start with three anecdotes.

First, in the year 2000 I was living and working in Indonesia working for the World Bank. As a way to address the fears of Y2K issues with programs the World Bank adopted a whole suite of software by SAP for managing its administrative processes. These processes were designed to push more of the workload from administrative to the professional staff. So, for instance, professional staff were forbidden (on threat of being fired) from asking their unit's administrative staff from entering their expense account data into the system. High powered professionals, with globally elite advanced degrees, were mandated to enter their own hotel bill amounts into the expense accounting software. Perhaps, just perhaps, at World Bank benefits-inclusive costs of administrative to professional staff at HQ this made economic sense. But at the relative price of me to my (super-competent) administrative staff this use of technology to reduce demand for low to medium skill labor by pushing the tasks onto globally high skill workers (me) was positively ludicrous. So, even in a large multi-national organization supposedly dominated by economists and economic thinking the choices of technological displacement were far from rational.

Second, coming back to the issue of airline check-in. In India, even during a period of very rapid growth, starting from at least the 1990s, has only seen "regular wage" employment increase very slowly. Even among urban males the fraction of employment in "regular wage" only increases from 42.5 to 43.5 percent of the population. Employment in the "organized" private sector in 2012 was only around 12 million people in a country of over a billion. And yet, in Delhi airport one can use a machine to check into a flight.

Third, a few years back I arrived at Entebbe airport in Uganda. It took my taxi 30 minutes to exit the airport because the airport had recently installed "pay yourself" machines to pay for the parking and so did not have an attended parking booth at the exit, which meant most people, expected a manned booth, arrived at the mechanized booth having not paid. While these was obviously just a transitional hiccup what must have occurred to all Ugandans, as it did to me, was "how is it that in a country with a youth bulge and a desperate desire for decent employment it makes sense to eliminate a parking lot attendant to collect parking fees?"

Here are my three reasons to be concerned.

First, R&D entails fixed costs that need to be recovered through prices if the spending is going to make sense ex post (and hence, ex ante with full information). However, when firms producing innovations can segment markets, they can price to different markets so that they recover the fixed costs with prices above marginal cost of production in some markets but then sell at lower cost, perhaps just covering marginal cost, in other markets. This implies that labor saving machines and technologies can be developed in rich countries and be profitable at the distorted relative prices in rich countries but then be sold in poorer countries at much, much lower prices such that, at those prices of machines and technology it is profitable to adopt, even though at global prices the innovation was always uneconomic.

Second, perhaps in manufacturing particularly but also in other domains, there are ways in which innovation creates production and value chains and organizational practices that essentially mean the employment elasticity with respect to local wages, conditional on the production chain, just is very low. In transport for instance, the shipping container has revolutionized the way that goods are moved around the world. This has led to enormous gains in port and transport productivity as there is very little need for labor to load and unload. But that means if one is going to be part of the global transport chain one needs to adopt the container handling machines and processes in the sending port—irrespective of the labor prices.

Third, as in my example with the World Bank and its global adoption of a software system tailored around HQ relative prices, one suspects that multi-nationals may adopt global practices honed around distorted rich country relative prices and it is just not worth it to re-engineer process more appropriate to other relative prices.

In addition to these issues of how technological changes are directly affecting employment in developing countries, there is the challenge that the technological innovation in rich countries compete head to head with jobs that formerly where offshored. For instance, advances in voice recognition and programming may make purely automated service calls, backed up by humans, more cost-effective than humans in call centers. Or, machines and technology[4] in factories may produce gains in quality that simply cannot be matched with more labor-intensive processes. In these cases, production at the lower labor costs, it may make sense to bring production back to richer countries, without bringing back many jobs to the rich country but at the same time reducing job growth in poorer countries.

6. Conclusion

There has been continuous, massive, and justified attention to the fact that carbon (and other greenhouse gas) emissions are underpriced because their use does not reflect the negative global externality they create through the current and rising future damages associated with climate change. A current proposed solution is impose a carbon tax, with proposals in the range of US$50 per ton of carbon, which suggests that currently carbon is underpriced relative to its current externality inclusive price by about 27 percent[5].

In contrast policy induced distortions in the USA raise the domestic cost of labor to firms by at least 500 percent over its global scarcity cost (and there is no reason to believe this is much different for nearly all OECD countries). This price distortion creates incentives for industrial country firms to offshore labor in a variety of ways, including creating factories and call centers

[4] I may note near the end of this paper that I have used neither the world "robot" nor the words "artificial intelligence" as it is not clear either of those have any particular analytic content and may cause as much confusion as profitability for their proponents (and not coincidentally).

[5] I calculate this from Metcalf (2019) who reports an average price of fossil fuels of $13.87 per million BTUs and that a US$50 carbon tax would raise that by $3.73 per million BTUs, or 27 percent.

in countries with lower unit labor costs. This has almost certainly benefited at least some developing countries in creating and sustaining rapid economic growth.

However, this price distortion also creates incentives for firms in industrial countries to engage in purposive research and development to displace jobs with non-job labor and to displace labor with machines and technology. This feedback response to higher cost jobs makes it harder for industrial countries to meet their own social goals for employment, wages, and benefits.

But this industrial country policy induced technological innovation is a negative externality to the rest of the world. The hardest problem facing nearly every developing country is creating "good jobs" for their population, and in some instances, their rapidly growing labor force, which is of low to medium skill by global criteria—which is precisely the skills whose jobs are being displaced by industrial country innovation.

I would argue that, relative to its size and importance this problem of the negative externality on the world's poorest of the technological choices of the richest, gets, for a variety of reasons, much, much less attention that it merits.

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