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**Distributed Manufacturing in Dayton:
Combating COVID-19 Through Public Service Employment**

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Abstract

With the decline in manufacturing in the United States following the 1980s, many once thriving cities began to fall into economic stagnation and decline. Dayton, Ohio is one of these cities, experiencing a mass exodus of its central industry, leaving behind a labor force with mismatched skills for the current job environment and a lack of opportunity. Such unemployment has only been exacerbated by the Great Recession and the more recent economic shutdown, stemming from the COVID-19 pandemic. To combat this decline and slow march to destitution, this paper proposes the implementation of a public service employment program (PSE) that utilizes distributed manufacturing to reskill and revitalize the Dayton population while serving to combat the further spread of COVID-19.

As a part of the Rust Belt, Dayton, Ohio has been subject to economic instability rooted in the boom and decline in midwestern American manufacturing. Acting as a laboratory city, Dayton housed numerous Fortune 500 companies, such as NCR, Mead, and Reynolds and Reynolds (Staley, 2008). Following its initial strength in the early 1900s, the latter portion of the century brought slow, economic decline. With the protracted decline of the American automotive industry, manufacturing in Dayton began its mass exodus. Though this is typically attributed to foreign labor competition incentivizing outsourcing, it can perhaps be better understood by observing the telos of a laboratory city. Companies in their infancy must make locational decisions to determine where to begin production and cultivate innovation. In doing so, the two primary choices are diverse cities and specialized cities. Diverse cities offer a wider set of backgrounds and information for a company to draw from in developing their production. Specialized cities, however, offer specific factors. This means there is a tradeoff between the two types of cities. Diverse cities mean higher prototyping costs but lower moving costs. This is because the company has less access to specialized inputs, however they have access to a wider array of inputs. Specialized cities have lower prototyping costs but higher moving costs. This is due to the inverse, meaning they would have to move from specialized city to specialized city to have access to the same breadth of inputs. In both cases, however, the companies ultimately move to a specialized city once they solidify their production method. Thus, applied to Dayton, in the early 1900s, these infant companies were able to benefit from information spillover, copying production and organizational methods from each other. However, once the companies grew and matured; the benefits of such diversity became outweighed by the benefits of moving to a specialized city where they would be able to fulfill their specific needs.

In recent years, however, there has been a resurgence in Dayton manufacturing. This, however, has come from an unlikely source. The site of the previous General Motors factory in Moraine, Ohio was converted into a Fuyao Glass America Inc. automotive glass producing factory. This returned jobs to an area previously devastated by the loss of what was essentially a monopsony. This, however, did not come without issues of its own. Firstly, cultural differences, largely regarding worker rights and protections, yields unstable employment. Rooted in this, is the deeper issue of a lack of reskilling. The benefit from this is the low reskilling requirements to shift the previous GM workers to Fuyao workers. However, this lack of upskilling the workforce results in kicking the can down the road, so to speak. With ever-increasing automation, such large, centralized manufacturing jobs are not sustainable.

Though there is some level of resurgence, there are large obstacles preventing a full return of traditional manufacturing to the Dayton area. Most notably is the environmental protections, especially in the downtown Dayton area. Montgomery County, where Dayton is located, relies on the Great Miami Buried Valley Aquifer for its water (Montgomery County, 2019). This issue this presents is that downtown Dayton is located on this aquifer, meaning stricter environmental protections must be implemented to prevent the contamination of the regional water supply. With downtown Dayton being the central business district (CBE) for area, which would typically be the ideal location for many businesses, stricter environmental protections can often disincentivize companies from locating there, due to the increased costs.

Government Intervention

With Dayton's large labor supply of manufacturing-skill based workers, it is necessary to introduce jobs that (1) are useful, (2) fit the skills of the workers, and (3) reskill the labor force.

With the environmental protections, quantity of low-skill workers, and lack of geographical incentives, it is highly improbable the market will be able to correct for the structurally unemployed in the region. This indicates the necessity of government intervention to prevent the further decline of this portion of the labor force. The typical methods the government would pursue in this situation would either be mass welfare, through methods such as Social Security Disability Insurance (SSDI), or relaxing regulations, pertaining to environmental restrictions or property taxes. Both of these methods, however, come with high costs. Choosing to put a substantial portion of the local population not only incurs high monetary costs to subsidize their living but also induces high social costs with the decay of self-actualization. Work does not merely provide income but also creates a sense of purpose and accomplishment for many people. It is important to note the importance of this sense of fulfillment is present throughout various economic school of thought, including institutional economics and behavioral economics (Pham, 2020). Pham (2020) states, “In the current world, many people find purpose in their work and simply substituting their hard-earned wages with unearned income would be a gross misapplication of economic theory” (p. 4). The opposite approach of trying to induce investment into the area by providing incentives for companies suffers from a fatal flaw rooted in game theory. As Dayton is not the only area suffering from elevated structural unemployment, other regions enter into what is essentially a bidding war, competing to draw firms to their localities. This means there is essentially a constant back and forth attempt to outbid the other parties, resulting in “overpaying” where the costs incurred to bring in the companies outweighs the benefits of the jobs that are created. This is especially evident when environmental protections are relaxed as it increases not only the monetary harm brought upon the population but also the physical harm as the region’s collective health suffers. With water pollution already an issue in

the Midwest, most notably Flint, Michigan's water crisis, the application of such environmental regulation's reduction in Dayton can be catastrophic. Should the Great Miami Buried Valley Aquifer be contaminated, the primary water source for the entire region would be jeopardized. To avoid these massive pitfalls, alternative measures must be considered. One such alternative is the implementation of Public Service Employment (PSE) programs. As outlined by Forstater (2004), PSE, otherwise known as the employer or last resort or a job guarantee program, is a governmental program that provides public employment to those that are willing and able to work. The main focus of such programs is to provide jobs to those unable to obtain positions in the private sector while also imparting skills upon them. Thus, this fulfills the second and third requirements put forth previously. However, this leaves the first requirement in a position of ambiguity. This is due to PSE's broad base of employment possibilities. The PSE proposed in this article focuses on a distributionally based program that will fulfill the three requirements as well as bring additional benefits.

Decentralization

With the dawn of capitalism, localized artisan manufacturing and home production slowly gave way to centralized factory production and the boom of towns and cities created for manufacturing rather than solely trade. This marked the era of economies of scale and long, linear supply chains. However, such economies of scale yield additional benefits only to a certain point. Once large enough, diseconomies of scale take hold, resulting in more costs than benefits. Such phenomena can be seen vicariously through the growth and spread of supercomputers.

Distributed Computing

To increase their performance, these supercomputers must either increase the number of processing units or increase the efficiency of each unit. This means that increasing performance of a supercomputer means massive investments into fixed costs associated with the upgrades. Released initially in 2000 and taking hold in the late 2010s, Folding@home (FAH), a distributed computing project initialized by Stanford University, has become the future of supercomputers (Folding@home, 2020). With the COVID-19 pandemic beginning in 2020, participation rates for FAH skyrocketed. As of March 25, 2020, FAH reached 1.5 exaflops of processing power, making it as fast as the top 25 supercomputers in the world combined (Hruska, 2020). By using decentralized processing in this way, the majority of costs are outsourced to participants. This applies not only to the variable costs of running the computers but also the fixed costs of acquiring and upgrading the computers. Though such a feat is staggering, it doesn't display any obvious means to be translated into a PSE. The key takeaway must be the distributed aspect which would need to be applied to other factors.

Distributed Manufacturing

The factor this PSE program applies the distributed aspect to is manufacturing. Much as there was a shift from localized production to centralized manufacturing, there now needs to be a shift back from centralization to localization. This, however, comes with a number of stipulations. First and foremost, this is not a regressive movement as this is created under an evolutionary, rather than teleological, framework. Secondly, though this is a return to decentralization, it is not a direct return to prior artisanal production. As noted by Srari, Kumar, Graham, Phillips, Tooze, Ford, Beecher, Raj, Gregory, Tiwari, Ravi, Neely, Shankar, Chamley,

and Tiwari (2016), the difference between artisanal production and distributed manufacturing is the consistency of work. Thus, it can be extrapolated that distributed manufacturing draws on the strengths of both prior centralized and decentralized manufacturing, through the mix of capabilities combining standardization with customization.

Distributed manufacturing is an umbrella term containing various production methods. To provide a narrower, more relevant scope for its role in the currently proposed PSE, it will pertain to the production of personal protection equipment (PPE). With the global spread of the COVID-19 pandemic, supply chains have become thin with the shift to a shortage economy. Though this affects a plethora of goods and services, one of the most vital products affected is the production and distribution of PPE, both to the healthcare industry as well as private consumers.

Cloth Masks

As COVID-19 is a highly infectious, airborne virus, demand for masks has sharply increased. With the governmental requisition of many forms of PPE, local production has begun to create cloth masks. Though these masks are nowhere near as effective at preventing the inhalation of infectious particulate as the standardized N95 masks and surgical masks, they are effective at reducing the expulsion of the particles from the host wearing the mask, as well as preventing the user from touching their mouth and nose. The relative simplicity of the creation of these masks paired with their vitalness during this period allow them to fulfill the first two requirements for the PSE, yet the fulfillment of the third requirement is shaky at best.

Face Shields

To create a successful PSE, the third requirement must be sufficiently fulfilled, not only the first two. Thus, the utilization of 3D printing can remedy the shortcomings of the production of cloth masks. Though the production of face masks via 3D printing is improbable, the creation of facemasks is possible and has already begun in various countries. Though there are currently various designs, the face shields can be broken down into two primary components, the clear plastic shield and some form of bracket or headband to affix it to the wearer's head. Though printing the shield section itself is likely possible, it would suffer from the tradeoff between clarity of vision and robustness. Therefore, this section of the mask is better suited for production via laser cutting plastic or plexiglass sheets. This is not particularly difficult to produce on scale, given its exceeding simplicity. However, the section that would benefit from distributed manufacturing is the holder segment. This portion would benefit greatly from 3D printing's propensity for customizability, given individual's preferences and head dimensions. More importantly, it would vastly decrease time for prototyping while increasing innovation. By widely distributing 3D printers, users can create their own designs to increase important factors such as comfort and durability for the face shields. Such flexibility afforded by production through decentralized 3D printing is especially vital during the current crisis as it provides quick adaptability, both in type and scale of production.

Therefore, utilizing 3D printing fulfills the first requirement as it would buffer against the shortage of vital supplies; it satisfies the second requirement as it has a relatively shallow learning curve, particularly with the vast body of information and tutorials on the internet; finally, it accomplishes the third requirement by providing new skills to the workers.

Specifically, the skills learned are computer based, something which is vital for upward mobility in many jobs now in the age of computers.

Public Service Employment Through 3D Printing

Due to the benefits of shifting to distributed manufacturing via the implementation of 3D printing, it is the ideal candidate for a PSE program in Dayton as a means to create jobs. This being said, it is necessary to clarify the role of the government in facilitating this shift. Unlike traditional PSE proposals, this follows a framework where the workers are essentially self-employed. This is accomplished by the government acting only to reduce the costs of production by providing a one-time tax credit per household to offset the fixed cost of purchasing a 3D printer. Input material costs are offset by further minor subsidies, as can be seen in the American agricultural industry. With the fixed costs for the printers ranging from roughly \$29-\$500 and filament costs ranging from approximately \$30-50 per kilogram, production costs are quite low (King, Babasola, Rozario, and Pearce, 2014). These fairly low costs are more than offset by the plethora of benefits such a shift would yield.

Feasibility

When discussing any public program, feasibility is of vital importance, especially when considering moving from centralized manufacturing to distributed manufacturing. A financial perspective is necessary to evaluate the possibility of funding job programs from the government to make the shift to distributed manufacturing. An analysis of the Green New Deal will shed light onto the highly possible funding of job programs that can be implemented into Dayton. This will ensure environmental protections for Dayton's water supply as well as the overall reduction

in carbon emissions in the local manufacturing sector, while still enjoying economic growth. This section is dedicated to exploring potential avenues of funding to transition Dayton into a decentralized manufacturing hub. Also, this warns a discussion on the political implications and environmental tradeoffs.

Traditionally, economic growth and environmental destruction go hand in hand. Stern (2018) estimated this relationship, employing the environmental Kuznets curve (EKC). Stern concludes “In faster growing middle income economies, the effects of rising income overwhelmed the contribution of technological change in reducing emissions” (pg. 525). Thus, this relationship is conceivably present in Dayton. However, the analysis is more concerned with the macroeconomics which, in the US, is subjected to more centralized manufacturing. This proposal does not retain our typical understanding of economic growth and the negative externalities incurred by the environment. This creation is designed and developed for the purpose of dispelling the notion that economic growth must come at a cost to the environment.

Moreover, understanding how this job programs is feasible can be explored through the context of the Green New Deal. Galvin and Healy (2020) examine the feasibility of the program and address its criticisms from a Keynesian economic perspective. The Green New Deal was introduced by Congresswomen Ocasio-Cortez and Senator Markey and is easily explored through Senator Bernie Sanders economic implementation strategy. The purpose of the deal is to reach a net zero emissions and reduce inequality through guaranteed jobs programs. Funding for the deal comes primarily from the government. There is nothing stopping the US government from creating money and then injected it into the economy to pay from workers, contractors, social welfare, and additional other benefits. This has the potential to cause inflation, but the government can withdraw money from economic circulation by raising taxes, charging fees, and

bonds issues. Senator Sanders and many other believe the \$16.3 trillion Green New Deal plan, which does not account for a universal healthcare system, would pay for itself in 15 years. This is made possible from eliminating fossil fuel subsidies, reduce military expenses to protect oil-shipping routes, selling energy via power marketing authorities, and income tax revenue from the estimated 20 million job creation. Thus, public assistance programs will be less necessary with more employed and raising taxes on the wealthy and large corporations will account for a substantial portion of the funding and alleviate the inflationary pressures (Galvin and Healy, 2020).

Although, the Green New Deal is tailored toward eliminating inequality among minority groups and women and they are not industry specific. Conceivably, the Green New Deal jobs program can be extended into distribution manufacturing jobs, such as proposed for Dayton. Increased tax revenues and a reduction in spending can aid in the transition of decentralizing manufacturing which is a form of climate mitigation. Essentially, these individuals will be self-employed and self-sufficient, capable of their own production that minimally harms the environment. Also, these citizens will be retooled with new skill sets and economic mobility, since they are making more money, enabling them to potentially acquire jobs within the private sector that were previously unattainable.

Now, some may critique distribution manufacturing as being less energy efficient since electricity would be required to be distributed further instead of it being centralized. However, Gwamuri et. al (2014) finds that distributed manufacturing is not only sustainable, but “using solar photovoltaic power the distributed manufacturing always has a lower environmental impact as compared to conventional manufacturing of polymer products” (pg. 36). This increased distribution of electricity is easily refuted as semi-mobile school-based systems have adopted

prototypes solar powered 3-D printing, which is very easily to transport since it can fit within a standard suitcase.

Politically, the Green New Deal and by extension our Dayton job proposals exists in murky waters at the moment. Haslett (2019) ABC News article highlights the push back from many conservative commentators who believe this is calling for the end of air travel and meat-based diets, and others like Megan Mullin a Duke environmental politics professor believe implementation is far from possible. However, Mullin is optimistic that the Green New Deal is beginning to change the conversation which acts as the beginning stages of policy reform (Haslett, 2019). Even with the large push back and limited political endorsement, Mark Jacobson professor of civil and environmental engineering at Stanford stated, “that 80 percent of the Green New Deal’s target of net-zero greenhouse emissions across the economy could be achieved by 2030, and 100 percent between 2040 and 2050” (Friedman and Gabriel, 2019). Since, there is no consensus on the overall feasibility, this point is in contention from a practical standpoint. Many researchers do believe in the Green New Deal and its financial feasibility but strong support against it is winning out. Within Dayton, it is unlikely a distributional manufacturing job guarantee program will receive heavy opposition. Dayton centralized manufacturing is relatively weak, and the economic growth is stagnated. Thus, a need for a solution is present. The overall solution might not be politically popular, but it should be in Dayton as there is a clear need for economic rejuvenation.

Conclusion

In conclusion, this paper is focuses on offering Dayton an alternative job program that would catapult the local economy and have limited environmental externalities. This solution is

imperative to the Dayton economy as it has experienced a mass exodus of manufacturing. The day and age of centralized manufacturing in Dayton are done. Therefore, something needs to replace the loss of industry and production. Distributed manufacturing is a solution that has become more feasible to implement within this local economy. Dayton water supply is relied on by the Great Miami Buried Valley Aquifer, this requires heavy regulation to ensure the water is not contaminated. Unfortunately, this comes at a high cost for business as production costs are no longer as affordable as transition to another local economy where restrictions are minimal. Thus, this gives rise to distributed manufacturing, making adherence to strict environmental regulations possible while still giving economic access to low skilled laborers.

Furthermore, this paper gives a detailed account of certain sector of the Dayton economy that would flourish with a new jobs program. Face shields, masks, and other commodities can easily be produced with 3D printing to aid not only the current coronavirus crisis but bring jobs back into the Dayton economy. This will have a variety of positive effects on economic activity, and, as it begins to grow, many other avenues will open for continual growth and development in this local economy. Most of all, this will be a very environmentally friendly proposition.

Moreover, this is a highly probable job program as the fixed and variable costs of distributed manufacturing are quite low. This was analyzed in the Green New Deal context, although this deal is not dedicated specifically to distributed manufacturing. It is conceivable a slight expansion on the already intensive deal can be funded through redistribution of funds and cutting funding in other areas of the economy. Also, local government need to begin the push for these initiatives. Political support for the Green New Deal is currently scarce, but successfully beginning to change the conversation with the growing stress of climate change. Overall, this plan is economically feasible, the next step is acquiring enough political support for

implementation. Undoubtedly, something is needed to bring Dayton's economy back to strength and a guaranteed job program that aims at increased manufacturing jobs and increased skill sets is an excellent start.

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