Expanding Health System Capacity in a Time of Crisis-Driven Demand:

Policy Priorities Rooted in Economic Insights from Historical Experience

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This note uses the Civil War era history of artificial arm and leg manufacturing to illustrate the power of manufacturing capacity to respond to clear prices and light regulation during times of dramatically heightened need.

Lessons from Historical Experience:

History and basic economics provide encouragement regarding the capacity for medical manufacturing the respond to crises. Faced with clear price signals and a light regulatory touch, the manufacturers of medical equipment can do amazing things.

Just prior to the Civil War, the 1860 the Census of Manufacturers documents that there were 5 manufacturers of artificial limbs in the United States. While quantities are difficult to pin down, available data suggest that roughly 350 artificial arms and legs were sold nationwide in 1860.[1]

The Civil War dramatically reshaped the landscapes of both the demand for and supply of artificial limbs. Changes in medicine and weapons technologies led to an unpresented number of amputee survivors during the Civil War. Historians place the number of amputee survivors at roughly 35,000 (Linker, 2011). Veterans' needs thus vastly outstripped the industry's pre-war levels of output. As documented in a fascinating medical history by Guy Hasegawa (2012), the federal government moved quickly to procure artificial arms and legs on a vast scale. In the Union Army program's peak year, 1865, it furnished 2,020 artificial legs and 1,441 artificial arms. The expanded manufacturing base, as documented by the 1870 Census of Manufacturers, consisted of 24 distinct establishments. In 1865, the production of artificial arms and legs for the Union Army alone was thus 10 times industry-wide production in 1860. In 1864, just the second full year of the Union Army's program, production had ramped up to between 1,600 and 1,700 artificial limbs, or 5 times industry-wide production in 1860.

How did this dramatic increase in the supply of artificial limbs come about? The key economic elements of the Union Army's program for procuring artificial limbs were clear prices and a light regulatory touch. Both are worth discussing in more detail.

The Union Army's artificial limb program paid manufacturers on a simple "fixed price" basis. During the bulk of the war, payments were set at $75 per leg and $50 per arm. While it is difficult to calculate and interpret inflation adjustments over such long time horizons, this translates into payments on the order of $1,000 to $2,000 per artificial arm or leg in today's dollars. Notably, these payments were lower than

[1] The 1860 Census of Manufacturers reports that the "annual value of products" in the artificial limb industry was $53,000. Anecdotal evidence suggests prevailing prices were around $150, suggesting that the artificial limb industry produced roughly 350 artificial arms and legs in that year.

the prices that prevailed prior to the war. The Union Army's program successfully gambled on the power of economies of scale, which made manufacturers willing to participate at low prices so long as they were able to produce at high volume. This was a risky decision, however, as manufacturing capacity might fail to materialize if prices are set too low. Rapid expansion of manufacturing capacity can be ensured by committing to transparent prices that are sufficiently high to ensure profitability.

The quality-assessment side of the Union Army's artificial limb program is more nuanced, though not dramatically so, than its approach to price setting. Its lessons are also important. To steer wounded veterans away from grifters and to ensure minimum standards of quality, manufacturers' prototypes had to be certified as "serviceable." Prototypes were reviewed by a panel consisting of physicians. The panel met periodically as it received inquiries from existing manufacturers as well as new inventors. During the war itself, prototypes were rated as serviceable or non-serviceable. "Serviceable" limbs became eligible for reimbursement while non-serviceable limbs did not. The board was empowered to set prices and protocols, as well as to enforce compliance on the part of manufacturers. Additional discussion of this history, coupled with an analysis of the accompanying wave of prosthetic device innovation, can be found in a more extensive analysis I conducted with Parker Rogers (Clemens and Rogers, 2020).

Discussion of Implications for Responding to Covid-19

The Civil War experience points to several lessons for current policy.

In the Covid-19 crisis, we need both "serviceable" and "state of the art" ventilators. Strong supply responses could be generated by imposing a single standard of serviceability, coupled with a commitment to pay a mark-up over recent prices for state of the art ventilators. A downside of this approach is that it risks overpaying for ventilators of middling quality. At present, however, moderately "over paying" is a second order concern. New capacity is desperately needed. More nuanced efforts to adjust payments for quality can wait for later.

Quality standards remain crucial, however, for diagnostic tests. A key issue with testing is that high error rates can increase strains on the rest of the system. False positives can lead to an immediate mis-allocation of short-run supply. False negatives can hasten Covid-19's spread by giving asymptomatic carriers a false sense of security. Accurate testing is thus quite important.

Expanding testing capacity is also vital. Here again, clear and generously set prices can work wonders. Innovative approaches can also have high value. One promising innovative approach is "pooling," whereby multiple samples are combined into a single test. If the result comes back negative, all samples are in the clear; if positive, testing of individual samples can pinpoint the true positive. Because Covid-19 has, to date, affected a small fraction of the population, this method can dramatically reduce the total number of tests required to screen the population as a whole (See recent discussion from Lipton and Regan, 2020).

Expanding the number of available medical personnel is also quite crucial. Here again, we should not let the perfect be the enemy of the good. Relaxing licensing requirement, as Mullainathan and Thaler have recently suggested in the New York Times by, is a sensible start. Finally, the pay of medical personnel should be increased both to stimulate supply and to compensate for elevated risks.

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Policy Principles:

The following principles can help to guide policy in its effort to encourage expansions of key elements of the health system's capacity:

1. **Clear price signals matter.** Send clear signals that new ventilators, beds, and tests will be generously reimbursed. Nothing gets private industry moving like a well-defined opportunity to profit by fulfilling a social need.

2. **Light-touch regulation will hasten the expansion of capacity for new medical equipment and structures**. We should not let the perfect be the enemy of the good when good is far better than nothing.

3. **It is more important to police the quality of diagnostic tests than the quality of equipment and structures.** False positive and false negative tests can worsen strains on other aspects of the system. Wildly inaccurate tests can be worse than no test.

4. **Entry barriers like licensing costs reduce the supply of medical personnel**. Physicians and nurses should not be inhibited from taking their practices to cities and states in greatest need. Recently retired physicians and nurses should face minimal hurdles in returning to work.

5. **Higher payments increase supply.** Efforts to expand supply by relaxing licensing requirement will be enhanced if accompanied by higher wages or higher reimbursement rates.

6. **Medical staff are now (relatively) underpaid if they have not been compensated for the increase in risk they face.** Higher payments may help to prevent medium-run burnout even if they do not generate short-run increases in work hours.