Donating blood, “the gift of life,” is among the noblest activities and it is performed worldwide nearly 100 million times annually (World Health Organization 2011). Massive blood donations after disasters—like the terrorist attacks on September 11, 2001, Hurricane Katrina in 2005, the Australian bushfires in 2009—exemplify human empathy and altruism. Unfortunately, because most such disasters only minimally affect demand for blood, spikes in blood donation after such disasters result in excess supply and (given blood’s limited shelf-life) have led later to destruction of supply (Starr 2002). Conversely, seasonal supply shortages of blood in winter and around holidays are more common. These supply and demand imbalances are not surprising given the lack of market prices (and shadow values) for collecting blood in many countries where donations are predominantly voluntary.

The economic perspective presented here shows how the gift of life, albeit noble and often motivated by altruism, is heavily influenced by standard economic forces including supply and demand, economies of scale, and moral hazard. These forces, shaped by technological advances, have driven the evolution of blood donation markets from thin one-to-one “marriage markets,” in which each recipient needed a personal blood donor, to thick, impersonalized, diffuse markets. Today, imbalances between aggregate supply and demand are a major challenge in blood markets, including excess supply after disasters and insufficient supply at other times. These

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imbalances are not unexpected given that the blood market operates without market prices and with limited storage length (about six weeks) for whole blood. Yet shifting to a system of paying blood donors seems a practical impossibility given attitudes toward paying blood donors and concerns that a paid system could compromise blood safety. Nonetheless, we believe that an economic perspective offers promising directions to increase supply and improve the supply and demand balance even in the presence of volunteer supply and with the absence of market prices.

**Background**

Blood products, which include whole blood, platelets, plasma, and its fractionated components, provide supplies for transfusions, surgeries, and many routine treatments. The current annual worldwide supply of whole blood is roughly 100 million units at 450 milliliters per unit (World Health Organization 2011). Transfusions of blood and plasma have saved tens of millions of lives, more than doubled the life expectancy of hemophiliacs, and improved health outcomes for many more people (Starr 1998; Hayes 2006). Even with a largely voluntary supply of blood, the blood industry can be regarded as a multibillion-dollar market because hospitals pay for blood products and charge patients for their use. For example, the cost of the components of each unit of blood sold to hospitals in the United States is approximately $570, with the cost for red blood cells at $229, platelets at $300, and plasma at $40 (Tracy 2010). Hospitals transfuse this blood at estimated costs of between $522 and $1,183 per unit in the United States and Europe (Shander et al. 2010; Abraham and Sun 2012). Of course, these prices are likely to underestimate social welfare because they ignore consumer surplus—suffering diminished and lives saved.

Systems for collecting blood are diverse across and within many countries. Wealthy countries rely heavily on unpaid volunteers for whole blood. Volunteer blood collection systems fall into four general subcategories: state-run monopolies, like Britain, France, Ireland, New Zealand, Canada; Red Cross-run monopolies, like Australia, Belgium, Luxembourg, The Netherlands; majority Red Cross-controlled, like the United States, Germany, and Austria; and majority independent blood banks, like Denmark, Italy, Norway, Portugal, and Spain. Healy (2000) discusses these categories, but finds few differences in outcomes between these systems. Several high-income countries also collect plasma through voluntary donation, like Australia, Belgium, France, New Zealand, and Japan, while others at least partially compensate suppliers, including the United States, Germany, Austria, and Lithuania (Eastlund 1998; Farrugia, Penrod, and Bult 2010). In the United States, with the highest percent of plasma products collected from paid suppliers, 81 percent of US plasma products were derived from compensated donors by 2004 (Flood et al. 2006). In poorer countries, blood typically comes from paid donors and “emergency-replacement” donors who are associated with recipients (and usually family and friends).
There is large variation across countries in the percentage of whole blood supply collected from volunteer donors. Thirty-seven percent of all countries collect their entire whole blood supply from volunteers, while another 36 percent collect under 50 percent from volunteers (World Health Organization 2011). Among countries with annual income exceeding $12,616 per capita (using the World Health Organization definition for higher-income countries), Figure 1 shows that over three-quarters rely on 100 percent volunteers, while 46 percent of the lower-income countries rely on other systems for over half of their supply.

Technology and Historical Events Shaping the Market for Blood

The first blood transfusion occurred in the 1600s and hundreds were performed by 1900, although most recipients did not survive. Three breakthroughs radically increased the likelihood of survival for recipients. In the 1800s,

1 The online appendix (available with this article at http://e-jep.org) shows absolute per capita paid and volunteer donations for all 144 countries for which we obtained data. The absolute per capita shares adjust for the fact that higher-income countries have higher per capita donations (as shown in Figure 2 later). The online appendix shows that the gap in absolute per capita donations from paid donors between lower- and higher-income countries is not as wide as suggested in Figure 1, though per capita donations from paid donors remains higher in almost all lower-income countries than higher-income countries.
sterilization gained widespread acceptance, greatly reducing infections caused when blood passed through tubes from donors to recipients. Karl Landsteiner’s 1900 discovery of blood types (O, A, and B) mitigated adverse effects from transfusing mismatched blood types. Last, mechanical devices were developed to control the blood flow and pressure entering recipients. By 1914 almost all recipients survived transfusions. With these quality improvements (the dramatically higher survival rates), demand for blood increased significantly and the quantity supplied rose in response, initially on a small scale due to an inability to store blood, resulting in “marriage market” set-ups in which each recipient needed a personal donor (1914–1937), then on a grander scale with the ability to store blood, resulting in today’s impersonalized, diffuse markets.

1914–1937: The Blood-on-the-Hoof Era

From 1914 to 1937, transfusions required blood to flow directly from donors to recipients because blood storage was not yet possible. Suppliers had to be present during transfusions and were thus referred to as “blood-on-the-hoof” (Starr 1998). Although requiring suppliers to be present is implausibly inefficient for large-scale demand, blood-on-the-hoof nonetheless had motivational advantages over current practices; being together, donors saw their donations being used and met recipients, thus eliminating social distance that exists today between anonymous suppliers and unknown recipients.

The most critical challenge during the blood-on-the-hoof era was to find people who could be available to donate when needed. To find these potential matches, hospitals and doctors built lists of people who were pre-screened for health and blood type and were readily available. To be readily available, donor-on-demand lists often included phone numbers for easy contact, and because having a phone in the early 1900s meant being relatively wealthy, donors-on-demand were likely to have relatively good health. The lower costs of pre-screening, greater availability when needed, and good health made donor-on-demand groups the main supply source for hospitals, doctors, and Red Cross agencies.

From the outset, there were both volunteer and paid blood donors. In London, Dr. Percy Oliver established one of the first volunteer groups with 20 donors in 1922 that grew to almost 900 by 1926. In New York, family and friends of patients were encouraged to donate, and individuals could earn $35 to $50 per donation. Given average annual income of around $1,200 (Whitley 1999), the New York Times (February 11, 1923) labeled donating blood the “1,001st Way to Make a Living;” the donation price attracted people whose benefit from donating, from altruism and compensation, exceeded their costs (time, discomfort, and health risks).

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2 Starr (1998) and Hayes (2006) provide engaging historical perspectives on blood donations. Many of the historical developments described in this essay can be found in greater depth in these books and the other specific references in this essay.
Foreshadowing future policy debates, concerns with transmitting viruses and bacteria existed from the outset. The New York Blood Transfusion Betterment Association provided safety guidelines to all donors: for example, recommending five weeks between donations, regular health checks, and deferrals for anemia. However, little enforcement, regulation, or oversight existed for another half century, indicating that safety concerns were not a dominant factor in the early years of blood collection.

Collecting blood could also be very profitable to those doing transfusions. Transfusions during this era required skilled doctors who could consequently earn a generous wage (as much as $500) for a single transfusion when a doctor’s average annual wage was around $3,380 (Paper-Dragon.com undated). Doctors sometimes did whatever was necessary to find blood; some walked the streets offering cash. Thus, both altruistic and economic (or financial) motives were present from the outset in the medical community and among donors.

1937–World War II: Economies of Scale and Impersonalized Diffuse Markets

In the mid to late 1930s, scientific developments occurred allowing for economies of scale in the blood supply. First, researchers developed the use of sodium citrate as an anti-coagulant (to prevent clotting) to store blood cost-effectively for up to two weeks (now six weeks). Blood banks opened immediately to collect and store blood; storage ended the blood-on-the-hoof (marriage market) era and ushered in the modern impersonalized supplier-recipient relationship. The benefits of blood banking—including the lower cost of moving blood rather than people, stockpiling capability, ability to collect supplies before running out, and today, testing and treating donated blood—vastly outweighed any potential negatives from the movement to an impersonalized market.

At the same time that storage became feasible, scientists learned how to separate whole blood into red cells, platelets, and plasma, and how to fractionate plasma into components (Giangrande 2010). Plasma components could then be a) stored cost-effectively for years, b) transported more safely and cost-effectively than whole blood, and c) combined from multiple suppliers into single packets and later distributed to multiple patients. The economies of scale were enormous.

World War II generated a surge in demand for blood products. Plasma and particularly the protein albumin (that assists in blood flow regulation) were vital to treat shock victims. During the war, more than 13 million units of whole blood were drawn by the American Red Cross alone (Hess and Thomas 2003). Such quantities necessitated more cost-effective collection, storage, and transportation; the first large-scale warehousing of plasma emerged, combining plasma from many individuals into single packets. To motivate donors, and with no price mechanism to adjust for excess demand, collection agencies and governments often linked donations to patriotism to increase the shadow value to donors. The initial US campaign to raise blood, “Plasma for Britain,” evolved into nationalistic donation campaigns to support US troops.
In the Aftermath of World War II

The volunteer-nationalism association in blood donation activities likely spilled over to post–World War II norms in many countries, including England, France, Poland, Switzerland, and the United States, that consequently relied primarily on volunteer blood supply immediately after the war. Countries where the link between blood supply and patriotism was weaker or nonexistent—for example, Japan, China, and Russia—primarily relied on paid blood supply immediately after the war.

The grim practicalities of World War II likely also affected attitudes towards blood supply safety. During the war, blood quality concerns like the risks of infections from transfusions were overshadowed by the need to increase the quantity of blood supplied, because the benefits of the high odds of surviving shock with a transfusion greatly outweighed the risks of contracting a blood-related infection, which at that time were mostly not life-threatening. Thus, combining donations from many individuals was considered acceptable, even though it meant viruses and bacteria like hepatitis B and syphilis could be transmitted from a single donor to as many as 60 patients.

Following the war, volunteer and paid supply coexisted across (and sometimes within) countries, with the balance often shifting over time. For instance, in the 20 years after World War II, Japan transitioned from paid to volunteer blood supply, while the United States went from almost entirely volunteer supply to having approximately 20 percent of blood products, primarily plasma, collected from paid supply.

1950s–Present: Demand Growth, Safety, Volunteerism

Since the 1950s, demand for whole blood and plasma products has increased dramatically and continues to increase today due to new medical procedures and aging populations. New procedures—including heart surgery, organ transplants, advanced natal care, and many cancer treatments—require increasingly large amounts of blood. The whole blood supply in the United States has increased from 4 million to 16 million units (450 milliliters per unit) from 1950 to 2006 and worldwide supply exceeded 92 million units in 2011 (World Health Organization 2011). Demand for plasma products has also increased rapidly. For instance, the annual supply of albumin—often used in the treatment of shock and severe burns—increased 20-fold from 30,000 pints at the end of the war to over 600,000 pints by 1990 (Peters 1996) and intravenous immunoglobulin—often used to fight infections—has increased more than five-fold from 15 to 80 tons from 1990 to 2006 (Flood et al. 2006).

While whole blood generally remains within country borders due to its relatively high transportation costs and six-week shelf life, plasma components have been actively traded internationally since World War II. Japan developed the first major for-profit plasma collection organization from paid donors, annually shipping up to $1.5 billion of plasma worldwide by the early 1960s. Other countries, including at least seven in Latin America and South Africa, were also exporting plasma from paid donors in the 1960s.
In the late 1960s, the newly discovered plasmapheresis process radically changed the amount of plasma donors could supply. The plasmapheresis process extracts whole blood, uses centrifuge or filtration to extract the plasma, and returns the red cells and platelets to the donor. Because the red cells are returned, donors have minimal risk of developing anemia and can thus donate 650 milliliters of plasma once or twice per week (compared to giving 250 milliliters of plasma once every 8 to 12 weeks from a whole blood donation). A plasmapheresis donor could thus donate 20 (or more) times more plasma than a whole blood donor. The disadvantage to a plasmapheresis donation is that the entire procedure takes nearly two hours (including 45 minutes for the draw and returning red cells) whereas whole blood takes about one hour (including 10 minutes for the draw).

The dramatic increase in the quantity of plasma that could be collected from the same number of donors using plasmapheresis, along with a willingness to pay donors, led the United States to become the dominant worldwide supplier of plasma in the 1970s. In contrast to most high-income countries relying on 100 percent volunteer plasma supply, by 2004, 81 percent of US plasma supply was collected from paid donors (Flood et al. 2006). In 2004, the United States collected almost 70 percent of the world’s plasma, with 40 percent eventually used in North America, 32 percent used in Europe, and 19 percent used in Asia (Flood et al. 2006).

To meet the growing demand for blood products, cost-effective methods to collect and store adequate blood supply had to be weighed against the safety of donors and recipients. Prior to the AIDS crisis of the 1980s, blood collection agencies tolerated more safety risks than today for a variety of reasons, including the nonexistence, unreliability, or high cost of testing for most infections, the unknown extent of health concerns and deaths from infected blood products, the lack of treatment for viruses and bacteria in blood products, and the lack of substantive government regulation and oversight of blood collection. Further, unawareness of the risks associated with subpopulations, combined with protecting the privacy of the volunteer donor, made many collection agencies unwilling to ask personal questions that might have helped screen out higher-risk donors. By the late 1960s, however, there was increasing awareness of infections spreading through blood products. For example, reports at that time estimated 17,000 cases of hepatitis per annum in the United States from blood donations, resulting in estimates of deaths ranging from 850 (Starr 1998) to 3,500 (Comptroller General 1976). Even with this awareness, a low-cost procedure to eradicate hepatitis B in plasma developed in the late 1960s was not commonly used until the early 1980s.

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[3] The Council of Europe guidelines suggest one plasma donation per week is safe, while guidelines from the US Food and Drug Administration indicate twice per week (Williams 2013).

[4] One can only wonder, had whole blood supply come from paid suppliers rather than volunteer donors whose motives were perceived as beyond reproach, whether protecting the privacy of donors would have outweighed the benefits of screening donors.
The arrival of AIDS in the early 1980s ushered in an era of aggressive screening and intolerance to risks concerning viruses spread through blood donations. When HIV was first detected, the initial assessment of the risks was underestimated, thus leading agencies to decide that destroying the vast stockpiles of plasma was too costly. With no reliable blood test for HIV at that time, a reluctance to screen donors regarding sensitive issues like sexual activity, and unwillingness to destroy stockpiles, AIDS spread rapidly. Over 14,000 people are estimated to have died of AIDS contracted from blood transfusions and 50 to 80 percent of hemophiliacs were infected by 1985 (Donegan 2003). Even with the availability of an effective treatment for preventing the spread of HIV in stockpiled plasma, the Canadian Red Cross implemented a seven month “transition” period before they required all plasma-based clotting factor to be treated, allowing the agency to distribute over eleven million units of untreated material (Starr 1998).

The underestimation of the HIV-related health risks was the tipping point that has made the safety of the blood supply the predominant concern for all blood collection related policies today. It led to aggressive donor screening and testing all donations, erring today if anything on the side of extreme caution. An example of the caution directly stemming from the AIDS era is the current restrictions with respect to CJD (Creutzfeldt–Jakob Disease or “mad cow disease”). The American Red Cross (2013) permanently defers potential blood donors if they spent more than five years in Europe since 1980 or three months in the UK between 1980–1996. Yet, the US Centers for Disease Control considers the risk of CJD infection almost eliminated and only three cases worldwide were ever traced to blood products (Brown et al. 2012).

The shifting views towards blood supply safety took place against the backdrop of an on-going debate in the 1960s and 1970s on paying donors for blood, which focused on blood supply safety and ethical considerations for donors. Titmuss’s 1971 book, The Gift Relationship, most prominently articulated the concerns. Titmuss argued that blood supply safety would be compromised by paying donors because it would attract higher-risk donors. He further believed that paying for blood donations would reduce donations because volunteers donating for altruistic reasons would be less willing to donate if paid. The Gift Relationship profoundly influenced policymakers (Healy 1999), and by 1975 the World Health Organization (2009) issued policy guidelines for countries to have 100 percent non-remunerated volunteer donations. The guidelines stand to this day and have been adopted by many blood collection agencies. However, Lacetera, Macis, and Slonim (2013) note that no empirical evidence using reputable data-gathering and econometric cause-and-effect analysis has ever tested Titmuss’s assertion using payments for donating actual blood. Such a test would be very difficult to

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5 Healy (1999) argues that Titmuss was using the blood context to raise broader concerns about markets, bolstering the argument with quotations from Titmuss (1971, p. 531) like this one, “[A]ltruism is morally better for society than the market. Markets are both inefficient and morally bankrupt. If blood remains a gift, then the system will stay efficient and the bonds of community will remain strong.”
carry out, because so many blood collection agency guidelines forbid paying for donations of whole blood.

The volunteer system has performed well in most high-income countries, providing higher per capita donations than in poorer countries relying on nonvolunteer supply to meet demand for whole blood (as evidenced below). However, it is impossible to say how well the volunteer system has performed in an absolute perspective; for example, it is possible that if the blood supply was to increase via a market mechanism that priced blood to its marginal value, then healthcare providers would find innovative uses for it such as the recent trials on the use of plasma derivatives to treat Alzheimer’s (Jeffrey 2013). In other words, volunteer supply may meet current demand because the health industry is not aggressively pursuing research and development that might lead to greater demand for blood that they recognize the volunteer system cannot supply.

The volunteer system, however, has not done well in meeting plasma demand. The United States is the only country that is totally self-sufficient in all blood and plasma products (Flood et al. 2006) and has accomplished this using a mostly for-profit plasma industry. Most other countries have to import at least some plasma products, with the single biggest importers being Germany, Austria, and Spain (Ayers 2013). Many countries remain unwilling to pay for plasma donations due to concerns regarding safety and ethics, which may explain the dramatically different usage rates for plasma products. For instance, in 2006 the US health care system used 105 grams per/1,000 people of the dominant plasma product (immunoglobulin) which was more than 250 percent of the rate in Italy, the United Kingdom, Germany, the Netherlands, and Japan (Flood et al. 2006), suggesting that the noncompensated plasma collection system might be limiting potential usage in many countries.

The major ethical consideration with paying for blood donations has been the potential exploitation of donors. As Roth (2007) discussed in this journal, certain transactions involving money can be perceived as repugnant, and these perceptions put real constraints on market transactions. While the World Health Organization guidelines are not legally binding, they have greatly reduced the option of offering economic rewards for blood donations in most high-income countries today. With no competitive market price for obtaining whole blood in these countries, supply of whole blood relies almost entirely on altruistic donations.

Repugnance alone cannot explain, however, why the US whole blood supply is almost entirely from volunteer (noncompensated) donors, while 81 percent of plasma is supplied by paid donors. This distinction did not always exist. Until 1978, paid and volunteer donations coexisted for both whole blood and plasma. In 1978, the Food and Drug Administration ruled that blood products had to be labeled as “paid” or “volunteer” (FDA Compliance Manual undated). Paid whole blood disappeared almost immediately, yet paid plasma continued to coexist with volunteer donations (Starr 1998). Objectively, repugnance arguments should apply equally to whole blood and plasma donations; both involve renewable body parts (in contrast for instance to donation of organs like kidneys), pose minimal health risks to donors, and both are open to exploitation concerns. Starr (1998) provides
an economic explanation that has little to do with moral arguments. He argues that hospitals believed in 1978 that whole blood from paid donors was more likely to have the hepatitis B virus and thus believed paid supply was inferior to volunteer supply. In contrast, hospitals and drug companies obtaining plasma made no such distinction between paid and volunteer plasma, because plasma donations were already being screened for hepatitis B. Further, because volunteer donors were able to supply sufficient quantities to meet demand for whole blood most of the time, the need for paid whole blood was low, whereas volunteer supply of plasma frequently could not meet demand. Today, despite reliable tests and treatments of whole blood, paying for whole blood remains almost nonexistent in the United States, while paying for plasma is the norm.

Current Conditions: Pricing, Supply, Safety, and Imbalances in Supply and Demand

Blood Prices

The price paid to agencies that collect whole blood is similar in the United States and Europe. Average prices in 2010 ranged from $154 to $211 per unit (Toner et al. 2011; Shander et al. 2010; Dreaper 2010) to cover operating costs of collecting and storing the blood that include staff, facilities, equipment, and testing. Prices are contracted and hence do not typically change with short-term fluctuations in supply or demand; only 12 percent of US hospitals report prices increasing during periods of shortage. US patients on average pay hospitals $334 per unit for whole blood (Toner et al. 2011).

The United States, Germany, and Austria collect a substantial share of plasma from paid donors, with the United States collecting 70 percent of the world supply (Flood et al. 2006). US plasma donors are typically paid $30 to $60 per donation depending on donation frequency (Blood Plasma Donation Tips 2013). Plasma is then aggregated and fractionated into its component parts and sold to hospitals and drug companies, who pay on average $61 per unit for plasma and $534 per unit for platelets (Toner et al. 2011). Plasma prices fluctuate with supply and demand factors; for example, with increased regulations increasing the costs to fractionators in the mid-1990s, the price of plasma products jumped more than 20 percent from 1996 to 1998 (Flood et al. 2006).

Quantity Supplied and Safety

Many surveys in wealthy countries suggest that the major motivations for people voluntarily donating blood are helping the community, friends, and relatives (Bednall and Bove 2011). These motivations appear sufficiently strong to generate greater per capita quantities and similar safety to other collection systems. Figure 2 shows the relationships between blood donations, income, and volunteerism, based on country-specific data and national blood agency data from approximately 7,000 blood collection agencies covering 144 countries (World Health Organization
Data are for 2008 or the closest possible year with comprehensive and publicly available data. We have four fewer observations in Figure 2 than Figure 1, that is, 144 countries instead of 148; Figure 2 uses GNI per capita data based on the World Bank Atlas method (http://data.worldbank.org/indicator/NY.GNP.PCAP.CD) whereas Figure 1 uses the World Bank income classification method (http://data.worldbank.org/about/country-classifications/country-and-lending-groups). The World Health Organization separates Quebec from the rest of Canada, because it runs its own blood collection operations. We did not include Quebec in these figures; it has higher per capita donations (66 per 1,000 people) than any country listed here.

The left panel of Figure 2 shows that per capita supply rises proportionally with log per capita gross national income (GNI). The three countries with the highest per capita donations, in descending order, are Australia, the United States, and Denmark. The 10 high-income countries with the lowest per capita donations are, in ascending order, Singapore, Oman, the United Arab Emirates, Qatar, Kuwait, Saudi Arabia, Japan, Poland, and Lithuania. The right panel shows a positive relationship between per capita supply and the percent of voluntary donations. In Panel B, Greece is the outlier country with below 50 percent donations from volunteers with just over 50 donations per 1,000. Table 1 presents some illustrative ordinary least squares regressions using these data. The first column presents ordinary least squares regression estimates of the correlation of country per capita supply with (the log of) gross national income. The estimates indicate that a country’s income is significantly positively correlated with per capita donations; 1 percent higher gross national income is associated with 8.8 extra donations per 1,000 people. The second column

\begin{itemize}
  \item [\textsuperscript{6}] A comprehensive list of references for the data can be found in the online appendix. The appendix lists the sources and years reported and where nonstandard procedures were used to obtain country-specific statistics. Figure 1 uses data from 148 countries using the WHO’s discrete income classifications whereas in Figures 2 and 3 we include 144 countries using a continuous measure of gross national income using the World Bank classification of country income (that is, the World Bank Classification Method).
\end{itemize}
shows a significant positive correlation between the percentage of blood collected from volunteer donations and per capita donations. The third column shows that even after controlling for income, countries with higher proportions of volunteer donations supply more blood; a one percentage point higher proportion of blood collected from volunteer donations is associated with 0.12 additional donations per 1,000 people.

We can use the same database to look at blood safety. To examine safety, we use a common measure of whether donated blood is discarded due to detection of a transfusion transmissible infection. Figure 3 illustrates the results. For countries with public information on transfusion transmissible infections, the left panel of Figure 3 shows a strong negative correlation between a country’s (log) gross national income and the percent of blood in which a transfusion transmissible infection was detected. The five countries with 20 percent or higher transfusion transmissible infections, in descending order, are Mauritania, Senegal, Mali, Central African Republic, and Niger. Again, Table 1 offers summary regressions. Column 4 in Table 1 shows the negative correlation between log of gross national income and transfusion transmissible infections (TTIs) is significant; a 1 percent higher gross national income is correlated with 3.3 percentage points fewer transfusion transmissible infections per donation. The right panel of Figure 3 shows little relationship between the percentage of blood collected from volunteer donations and transfusion transmissible infections. Columns 5 and 6 confirm an insignificant relationship

Table 1

<table>
<thead>
<tr>
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<th>Donations /1,000</th>
<th>Percent TTI/donation</th>
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<td></td>
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<td>(2)</td>
</tr>
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<td>log(GNI)</td>
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<td>7.97***</td>
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<tr>
<td></td>
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<td>(0.63)</td>
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<tr>
<td>Percent volunteer</td>
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<td>0.12***</td>
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<td></td>
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<td>(0.02)</td>
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<td>0.22</td>
</tr>
<tr>
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<td>144</td>
</tr>
</tbody>
</table>

Note: Percent TTI/donation is a measure of how much donated blood is discarded due to detection of a transfusion transmissible infection (TTI). Data are for 2008 or the closest possible year with comprehensive and publicly available data. Calculations use robust standard errors. *** $p < .01$.

7 The actual percent of blood collected from volunteer donations is reported in 67 countries. The remaining 77 countries only report the percent collected from volunteers within the categories specified by the World Health Organization: < 25 percent, 25–49.9 percent, 50–89.9 percent, 90–98.9 percent, and 99–100 percent. Alternative specifications in which we use the categories as dummy variables or we limit the analyses to only countries that report actual percentages provide qualitatively similar results.
between volunteer donations and transfusion transmissible infections, and log of gross national income remains significant after controlling for the percentage share collected from volunteers. Thus, while volunteer and nonvolunteer donor characteristics may differ, on the critical issue of blood safety, we find no evidence that countries with higher percentages of volunteer donors provide safer blood.

However, interpretation of safety based on percent of donations with transfusion transmissible infections should be done with caution. For instance, countries with a higher proportion of volunteers may test a higher proportion of donated blood or test for a broader range of infections and viruses. The safety results should also be interpreted with caution since they rely on only 45 countries, and many high-income countries, including the United States, do not report these statistics publicly.

Figure 3
Country-Level Presence of Transfusion Transmissible Infections (TTI), by Income and Voluntary Status

Note: This figure includes data for 45 countries. Data are for 2008 or the closest possible year with comprehensive and publicly available data.

Imbalances in Supply and Demand for Blood

With no market price for whole blood donations and with limited storage length for whole blood, coordinating demand and volunteer supply has been subject to episodes of both excess supply and shortages. Supply spikes often occur after disasters, due to suppliers’ altruistic responses and inadequate market signals.

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8 Donation decisions may be influenced by perceptions of the effectiveness, safety, and fairness of the system that may or may not match the objective data. To assess whether relationships based on perceptions differed from those based on objective data, we ran a survey using Amazon Mechanical Turk (https://www.mturk.com) to explore attitudes towards blood donations across 78 high- and low-income countries. The survey and overview of the results are available with the online appendix. The results show that, similar to the objective data, controlling for a country’s income, respondents from volunteer collection countries are more likely to believe their country is collecting blood efficiently and distributing it fairly ($p < .05$). However, respondent’s perceptions of the safety to either the donor or recipient do not vary with the percent of blood collected from volunteers ($p > .85$).
that would have revealed little or no shift in demand. Spikes in donations, combined with six week shelf life for whole blood, along with technical constraints and collection agency policies, have led to destroying blood supply after national disasters. Starr (2002) documents that over 570,000 additional units of blood were collected by the Red Cross immediately after the terrorist attacks of 9/11, with an estimated 100,000 to 300,000 units eventually discarded (plus the time and equipment wasted collecting these units), for an estimated minimum cost of $21–63 million (using the $211 unit cost reported above). Well-publicized images of lines outside blood donor centers immediately after 9/11 likely exacerbated the problem by signaling that donating was the normatively appropriate behavioral response (Cialdini et al. 1993), despite virtually no change in demand for blood.

Of course, one option for collection agencies to address excess supply is to separate the red cells, platelets, and plasma, with the idea that at least the plasma can be stored, although the red cells would still be discarded after six weeks. This option is limited by centrifuge and filtration capacity constraints. When a disaster response is local, supply can be shipped to other locations having centrifuge and filtration capacity. However, when disaster responses are spread over a larger area or are national in scope, there is nowhere to send the excess supply. Yet another option is for collection agencies to turn away volunteer donors, though this policy has not usually been followed for fear that volunteers may take this as a signal that they should not bother donating in the future.

It is also common for volunteer supply to fall below demand, especially during the winter (when suppliers are less able to donate due to higher rates of colds and the flu) and holiday periods (when people travel). The first response to these shortages from blood collection agencies is to employ higher marginal cost strategies to obtain supply, like running additional mass media advertising appeals and increasing direct communications. If such steps prove inadequate, then hospitals which are unable to receive enough supply must prioritize their usage and postpone transfusions and elective surgeries. Toner et al. (2011) report that 58 percent of US hospitals surveyed have postponed transfusions and 46 percent have postponed surgeries, while 14 and 13 percent have cancelled transfusions and surgeries, respectively.

How Economists Can Improve the Market for Blood

The preceding discussion suggests that the whole blood donation market in wealthy countries today is characterized by volunteer supply motivated by altruism. In the absence of a price mechanism to coordinate supply and demand, there is no a priori reason to believe supply and demand will be in balance. Economists can provide solutions to both increase supply and improve the balance.

Recent research suggests several avenues to increase supply. Lacetera and Macis (2010) report higher donations from symbolic rewards (medals) and social recognition (newspaper recognition) among all donors in an Italian town. Goette, Stutzer, and Zehnder (2011), examining 1,838 students, find that requiring people to say...
Non-price Signals and a Blood Registry

In the current volunteer blood donation context, the absence of a market price means that donors may donate when blood is not needed and not donate when it is needed. Because blood donors are a diffuse and independent group who make decisions with limited information on needs (given that there is no price to indicate higher or lower need), they cannot easily coordinate their actions. A central clearinghouse system can provide this coordination in the absence of a price signal, and economic market design principles can be used to fashion these operations.

To address shortages, most blood services use a combination of strategies, including media and telemarketing. These strategies can increase supply, but do not solve coordination problems. Introducing a donor registry to be used during times of shortages can better coordinate donor actions and be more cost-effective to the collection agency. The registry collects information from blood donors on their preferences about when to donate; for example, some people are more willing to donate if there is a particular need for blood of their personal blood type or in their own community. The critical assumptions for the registry’s success are that its members 1) are willing to donate when there is a specific need, but unlikely otherwise, and 2) know they will...
only be invited to donate when there is demand matching their preferences. Thus, the registry informs marginal donors when the shadow value of their donation rises.\textsuperscript{9}

To test the efficacy of a donor registry, we ran a field experiment with the Australian Red Cross Blood Service. Australia is a high-income country with a well-established 100 percent volunteer blood supply and has the highest per capita donations of any country. The Blood Service, with approximately 4,000 paid employees that include donor center operational staff like nurses and lab technicians, as well as telemarketers, is responsible for Australia’s entire blood collection and distribution. This national monopoly is ideal for studying the market for blood because the Blood Service manages all blood donations, communications, appointments, bloodstocks, and demand information for the entire market.

The study examined 13,200 “long-lapsed” donors, defined as past donors who have not donated for at least two years. Most long-lapsed donors are eligible to donate but unlikely to return on their own, having an annual reactivation rate under 1 percent. Because long-lapsed donors stop receiving targeted Blood Service marketing, our study was the only direct communication with them on blood donation. The subjects were randomly chosen from the universe of 44,222 long-lapsed donors between the ages of 23 and 60 and who last donated between 27 and 43 months prior to our first attempted communication with them. We have substantial demographic information and donation behavior including donation history and eligibility. We randomly divided the 13,200 donors into 9,000 registry and 4,200 control subjects each having an equal number of men and women and equal distribution across three past donation categories: one past donation, two or three past donations, and four or more past donations.

The Blood Service’s National Call Center called 9,000 of the subjects to invite them to join the registry, telling them that they would only be contacted “when the community has a critical need for blood, for example a need for your own blood type or a need in your local area,” and that they would probably only be contacted once or twice a year. The Call Center reached and invited 2,588 of these potential donors who were still eligible to donate; almost all of those not invited were subjects not answering the attempted phone calls. Among the 2,588 past donors contacted, 1,914 (74 percent) agreed to join the registry.\textsuperscript{10}

\textsuperscript{9} Two closely related mechanisms the registry may also operate through are: 1) the foot-in-the-door technique (Burger 1999) which requires small involvement initially (joining the registry) then the larger sacrifice (donation) later; and 2) as a precommitment device (de Hooge, Breugelmans, and Zeelenberg 2008), with joining the registry being an implicit promise to donate later, thus raising the (psychological) cost to say no later. Distinguishing between these paths and the shadow value are empirically difficult, but we would expect the shadow value path would not fade over the longer term, a finding which is consistent with our results.

\textsuperscript{10} Subjects invited to join the registry were divided into three sub-treatments to see if the invitation to join the registry crowded out making a donation immediately. Comparing immediate donations among donors invited to both join the registry and donate immediately with a control group that was only invited to donate immediately, we found no crowding. The sub-treatments let us further test whether being asked to donate affected joining the registry. Comparing the decision to join the registry among donors invited to join the registry and donate immediately with a group invited to join the registry only, we found no difference.
Three to five months later, the Call Center called all registry members plus 2,400 control subjects (who the center had not attempted to contact previously) to invite them to donate blood during the winter blood shortage period. The script explained that “so many of our regular donors are unable to give due to having colds or the flu around this time, but Australia continues to need over 26,000 donations every week just to meet the ongoing needs of patients.” We found that 9.0 percent of registry members but only 5.5 percent of control donors presented themselves to donate within four weeks. (Most attendances are within four weeks of calling, but the results are qualitatively similar using longer time-frames.) This greater registry response was not because registry members were more likely to be contacted than control subjects; examining only eligible subjects who were reached by phone, 32.1 percent of registry members but only 20.8 percent of control subjects presented to donate, a 54 percent (32.1 percent/20.8 percent) relatively higher donation rate. The registry effects reported here are statistically significant in probit regression analysis controlling for many factors including past donations, time since last donation, whether deferred at their last donation, demographics, and experimental design features like including dummy variables for specific Call Center agents and for call dates (detailed regression results are available in the online appendix). Moreover, when called one year later to donate during the following winter shortage, the results were qualitatively similar; among all subjects we attempted to contact in July/August 2013, 9.7 percent of registry members but only 5.9 percent of control subjects presented to donate within four weeks of receiving the calls. Last, in a separate treatment, when the Call Center invitation more strongly justified the need for donating by explaining “the blood levels are very low and donations of your type <A/O> blood are urgently needed. Many Australians with life-threatening conditions will need blood in the next few weeks to stay alive,” the registry effects were even larger.

Thus, our registry design that initially invited long-lapsed donors to join the registry and later called those who joined to make a donation during a critical need produces the same number of donations for fewer calls (or more donations for the same number of calls). Moreover, the registry increases donations during shortages and increases donor welfare by inviting donations when the shadow value of donating is higher to the supplier. Future registry formats might improve on our design by exploiting potential heterogeneous donation preferences such as preferring to donate at specific times of the year, for local needs vs. national needs, or for specific purposes (like accident victims or military personnel).

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11 The significance cannot be explained by the 26 percent attrition among subjects who did not join the registry. For instance, even if we remove 26 percent of the control subjects (who chose not to donate) from our analysis, there is still a significantly higher percent of donations among registry members than among the remaining control subjects.
Discussion

The market for blood—along with many other “products” and services such as organ donations, adoption, surrogacy, and dating services—is constrained by deeply entrenched social norms and ethical and safety concerns. In the case of the supply and demand for blood donations, a combination of these concerns, together with historical events, has led to a reliance on volunteer donations for whole blood. Our evidence of the current state of the whole blood market indicates that countries with higher percentages of volunteer donors are associated with a higher quantity of blood donations, even after controlling for per capita income, but do not provide safer blood.

We expect that limited experiments with incentives to donate blood will continue, and perhaps a few countries will move toward remunerated systems. After all, although the United States is essentially all-volunteer for whole blood, the US plasma market has long been dominated by commercial operations which have made the United States the world’s major supplier of plasma products meeting the needs of countries that rely on volunteer plasma. Social norms evolve over time, but the use of explicit prices for whole blood, at least on any widespread basis, will remain infeasible in most high-income countries unless current policies change. Hence, given the social welfare importance of the market for blood and the lack of substitutes, market innovations that improve the balance between supply and demand within the constraints of volunteer systems are needed. Nonprice signals that operate within social and ethical constraints should seek to provide a higher shadow value to motivate marginal blood donors to donate when the quantity of blood supplied falls below the quantity demanded. We described the success of one design that introduces a registry to improve the central clearinghouse functions of blood collection agencies. More innovations in this direction, using economic market design tools, have the potential to improve welfare significantly.

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