

Comparing Legal and Alternative Institutions in Commerce*

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Abstract

The extraordinary economic performance of China and India in recent decades raises questions about the conventional wisdom of using the legal system as the basis of commerce. Despite many well-known advantages, the legal system can be captured by interest groups and become a barrier to change. We argue that one way to solve this problem is *not* to use the law as the basis for commerce but instead to use alternative mechanisms *outside* the legal system. Our prior work on China and India suggests that these alternative mechanisms can be quite effective. In the context of a fast-growing economy such as China or India, there is an additional advantage that this type of system can adapt and change much more quickly than when the law is used. In particular, competition can ensure the most efficient mechanism prevails and this process does not require persuading the legislature and the electorate to revise the law when circumstances change.

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I. Introduction

The economic achievements of China in the past three decades have been remarkable. Its economic growth and transition from a central-planning to a market-based economy represent one of the greatest economic transformations in history. India has also been very successful in terms of economic growth during the past two decades. At the end of 2007, China and India together accounted for 40% of the world population and about 20% of the world GDP in Purchasing Power Parity terms (see Table 1 below for more details). With growth rates among the highest of all countries, these two countries will play an increasingly more important role in the world economy for years to come.

The conventional wisdom is that to be successful in terms of long-run economic growth a country needs good institutions. In particular, it needs a good legal system that enforces contracts and resolves disputes, and a good financial system including financial markets and a banking sector to fund firm growth. In earlier work (Allen, Qian, and Qian, AQQ 2005; Allen, Chakrabarti, De, Qian, and Qian; ACDQQ 2007) we have documented that China and India do not have these. In fact, the governments of these countries are notoriously corrupt, the legal systems are ineffective and the financial markets and banks are small relative to their economies and inefficient.

Most observers would characterize the economic performance in China and India as ‘successful *despite* the lack of western-style institutions.’ By contrast, we argue in this paper that these economies have been successful *because of* this lack of western-style institutions – in that conducting business outside the legal system in fast-growing economies such as China and India can actually be superior to using the law as the basis for commerce. Our focus is on dispute resolution and contract enforcement mechanisms based on law and courts vs. alternative mechanisms operating outside the legal system.

We advance our main thesis by first describing a number of examples on how alternative

mechanisms work and on the problems with using the law and legal system in commerce. A good example of how alternative mechanisms 'substitute' for legal mechanisms is the practice of corporate sectors in China and India. Based on earlier work we demonstrate that despite the differences in their history of developing laws and formal institutions, firms in these countries operate in an underdeveloped legal system (China) or a sophisticated legal system on paper but of limited use in practice (India). To a large extent firms conduct business outside the legal system and do not rely on formal financing channels from financial markets or banks for most of their financing needs. Instead, they use nonlegal methods based on reputation, relationships and trust to settle disputes and enforce contracts, and rely on alternative financing channels such as trade credits and funds from family and friends, backed by the nonlegal mechanisms, to finance their growth.

To highlight the problems of using the law and legal system as the basis for commerce, we focus on examples in developed countries such as the U.S. The reason for this choice is obvious. If there are deficiencies in using the legal system in countries with the most developed institutions, these deficiencies will be magnified in developing countries with underdeveloped institutions.

A frequently talked about and controversial topic is intellectual property rights including patents and copyrights. The practice of enforcing intellectual property rights by courts is much more vigilant and prevalent in developed countries than in developing countries. There is a widespread belief in developed countries that such protection is essential but this belief is not shared in the developing world. What is the empirical evidence? An extensive literature in industrial organization in economics has found mixed results on the relationship between patent/copyright protection and the pace of innovations. On the one hand, exclusive property rights provide strong incentives for innovations and do lead to more innovations in some industries such as chemicals and pharmaceuticals. On the other hand, such positive relationship between protection and pace of innovations is not observed in many other industries; instead, excessive protection deters

competition, which is another important factor in spurring innovations. One of the problems with the patent/copyright and litigation systems is that they induce rent-seeking behaviors by vested interest groups and individuals. With abundant resources they can undertake various measures and use the legal system to block competition and innovations from other individuals or smaller companies, and this type of behavior reduces social welfare.

Another potential problem of using the law lies in the legal system capacity and fixed costs associated with revising the law as required by changes in commerce. In democracies, the legislature must approve any revisions in the law before corporations and investors can freely implement new techniques in their activities and transactions in practice. However, in any given period politicians have limited time and effort to devote to one area of the law, implying a fixed cost in revising the law. A good example illustrating such limited capacity and fixed costs is the U.S. payment system. At the beginning of the 21st Century the U.S. had a 19th Century system, relying mostly on checks and the mail, and significantly lagging behind other developed nations. Checks had to be physically transported from where they were deposited to a central operations center, then to the clearer and then back to the banks they were drawn on. This process significantly delayed business transactions as compared to electronic methods.

Despite repeated calls for changes from the banks and businesses, it appeared that the U.S. Congress was not interested in solving this seemingly simple yet costly problem, until September 11, 2001. After the terrorist attack all commercial flights in the U.S. were grounded for several days, completely halting the check clearing process. The Check Clearing for the 21st Century Act was signed in October 2003, allowing electronic images to be a substitute for the original checks, and thus the clearing process is no longer dependent on the mail and transportation system.

In a final set of examples we show that alternative mechanisms can handle disputes from complicated transactions. The diamond industry has historically operated outside the legal system

(of any one country) and flourished worldwide despite the lack of transparency of most of its dispute resolutions. Another industry that has relied on out-of-court mediations and arbitrations to settle disputes is reinsurance. In recent years it appears that selecting objective arbitrators has become a lengthy process that significantly delays the arbitration process, particularly in large scale transactions, and the industry has been revising the traditional procedure in order to expedite the process without losing sight of fairness.

These examples motivate our analysis on the advantages and disadvantages of legal institutions and alternative institutions. The use of legal systems as the basis of commerce has many well-known advantages. The legal system from a democracy allows equal and full access by all and fairness in trials and settlements. With powerful enforcement mechanisms including civil and criminal penalties, disputing agents and firms have strong incentives to follow the resolutions backed by the legal system and government, which in turn provides long-term stability on how things should be done in practice. By using the entire legal operator and system, the marginal enforcement costs can be very low and this improves overall efficiency.

However, there are also disadvantages in using the legal institutions. First, recent research on political economy factors, and in particular, work by Rajan and Zingales (2003a,b) argues that rent-seeking behaviors by vested interest groups can turn legal institutions into barriers to changes. We expect these problems to be much more severe in developing countries and the costs of building good institutions can be enormous in these countries. We argue that one way to solve this problem is not to use the law as the basis for commerce but instead to use alternative mechanisms. Second, as shown by the example of U.S. payment system reform, legal system capacity can impose significant fixed costs in revising the law and thus delaying the pace of innovations. These fixed costs can further increase if the people in charge of revising the law (e.g., politicians and judges) lack the expertise of business transactions. In addition, interest groups with more resources may

receive more protection than individuals and this asymmetric protection system induces more rent-seeking behaviors and further deters innovations.

In the context of a fast growing economy, such as that of China or India, characterized by frequent fundamental changes in commerce and the economy, the disadvantages of using the legal system can overshadow its advantages, and it may be better to conduct commerce not using the law and legal system. In addition to minimizing the political economy costs of using the legal institutions, using alternative mechanisms has the advantage that they can adapt and change much more quickly than when the law is used. In particular, competition among different mechanisms and networks can often ensure the most efficient prevails and it is not necessary to persuade the legislature and the electorate that the law needs to be revised when circumstances change.

There are also limitations to alternative mechanisms. By design these mechanisms often exist within a network (or networks) of firms and investors, and may be inaccessible to outsiders and the limited access can come with the price of biases favoring insiders. With frequent changes and limited enforcement (since penalties cannot be imposed with authority), these systems generate instability and hence weak long-term incentives. While in a fast-growing economy profit-sharing in the long run and reputation-based mechanisms can ensure ‘good’ (cooperative) behavior, these mechanisms may be insufficient to induce such behavior in environments with limited long-term profits. On the other hand, in such static environments with infrequent changes to the fundamentals, the fixed costs of using the legal system are relatively small (especially in large transactions) and hence the law and legal system become superior to the alternative mechanisms.

Overall, we conclude that while legal mechanisms are an important part of developed economies’ institutions, alternative mechanisms play a much more prominent role in emerging economies, and can be superior to legal mechanisms in supporting business transactions in certain industries or entire economies. Therefore, our main policy implication is that in emerging

economies alternative dispute resolution and contract enforcement mechanisms should be encouraged and developed alongside the development of legal and other formal institutions. The coexistence of and competition between alternative and legal mechanisms can also exert positive impact on the development of legal institutions, so that they are less likely to be captured by interest groups and become more efficient in adapting to changes.

The rest of the paper is organized as follows. In Section II, we present a series of examples demonstrating how alternative mechanisms work and illustrating the problems with using the law and legal system as the basis for commerce. In Section III we compare and contrast the advantages and disadvantages of alternative and legal mechanisms and discuss policy implications. Finally, Section V concludes.

II. Examples on Alternative Mechanisms and Problems with the Legal System

In this section we first provide descriptions on legal protection of investors in practice and how alternative mechanisms work and substitute for legal mechanisms among corporate sectors in China and India. We then present examples that illustrate potential problems with using the law and legal system as basis for commerce. As indicated earlier, we focus on examples in developed countries such as the U.S. in order to emphasize the nature of the inefficiencies of legal institutions.

II.1 Alternative Mechanisms in China and India

Table 1 presents information from IMF on GDP based on simple exchange rates, GDP based on purchasing power parity (PPP), growth rate in GDP and GDP per capita in constant prices during 1990-2007 for the top twenty countries in *each* category. China is leading the chart in terms of growth rates of GDP and per capita GDP, while India's growth rates are the third (GDP) and fifth highest (per capita GDP) in the world during the period 1990-2007. At the end of 2007, China's

PPP-adjusted GDP is the second largest and India's PPP-adjusted GDP is the third largest in the world. If current growth rates persist, China's economy (PPP-adjusted) will overtake the U.S. to become the largest economy in the world in 2010, and double the size of US economy by 2020.¹ With 40% of the world's population and the status as the two largest and fastest growing emerging markets in the world, China and India are expected to play an increasingly important role in the global economy for years to come.

The remarkable economic performance of China and India also presents significant counterexamples to existing literature on law, institutions, finance, and growth. The conventional wisdom is that a necessary condition for long-run economic growth is good institutions, including a legal system that enforces contracts and resolves disputes, a financial system with efficient financial markets and a banking sector, and a democratic and benign government. However, AQQ (2005) and ACDQQ (2007) document that both China and India have weak and underdeveloped institutions. In particular, the legal systems are ineffective, the markets and banks are small relative to the economies and have played a limited role in allocating resources to most efficient uses, and the governments are among the most corrupt in the world.

These two countries also present distinctly different cases in their histories of developing western-style legal and other formal institutions. Transiting from a socialist system to a market-based system, China had no formal commercial legal system and associated institutions in place when its economy began to take off in the 1980s. However, historically China had highly commercialized societies without the development of western institutions. India, on the other hand, has a long history of Western legal institutions and financial markets due to its colonial ties to the U.K., and inherited a set of rich institutions. Based on the British judicial system, India's formal

¹ The World Bank significantly adjusted its PPP-based estimates of GDP for large emerging countries such as China and India downward in 2008; a third source, the CIA, produces PPP-figures that are in between those from the IMF and the World Bank. More information is available from the websites of these organizations, and from the authors upon request. Also see Heston (2008) for a review and comparison of different PPP-based GDP figures and methodologies.

legal system dates back more than two centuries. The State Bank of India, the largest commercial bank in the country in terms of deposits as well as assets, is over two hundred years old and thriving. The Bombay Stock Exchange (BSE), at 130 years, is the oldest in Asia. Yet, Indian firms, like Chinese firms, generally conduct business outside the legal system.

There are notable alternative views to the law and finance literature. For example, Rajan and Zingales (2003a; 2003b) suggest that development of formal financial system may trigger political economy costs, causing a disconnection between the level of financial market activity and economic development. Similarly, Acemoglu and Johnson (2005) find that while “contracting institutions,” or laws protecting contracts between individual parties, do not affect long-term growth, “property rights institutions,” or laws and regulations restraining powerful elites and the government, do affect economic growth. We argue that a common theme from the experience in China and India is that by using alternative mechanisms the political economy costs of using the legal institutions can be minimized.

What economic lessons can be learned from the remarkable performance of China and India? Are they simply applying the conventional wisdom, or are they doing something fundamentally different that (Western) economists have yet to fully understand? While most scholars would characterize the economic achievements in China and India as ‘successful in spite of their lack of western-style institutions,’ we argue that they have been successful because they have not relied on western-style institutions to develop commerce.

In this regard, China presents the extreme example. In the West, we take it for granted that finance and commerce should be undertaken using the law as the basis for contracts. Many would agree that the same should be applied for China:

“The modern corporation on a Western model would be the essential vehicle for private economic development.”

Interestingly, this was not written today but rather was the view of China's first Company Law in 1904 (*Gongsiliu*), drafted by the newly created Ministry of Commerce (*Shangbu*) of the waning Qing government aimed at promoting China's industrial development. Several subsequent versions of the Company Law (1904-1946) have tried to promote the development of share-holding firms with limited liabilities, but despite these attempts the model of western-style corporations was never taken up in China. An important factor is that the philosophy of having a disperse ownership including outsiders and insiders runs directly against China's traditional business model of keeping business 'within the family.' Indeed, most family-based firms' fear of incorporation stemmed from their distrust of government and unwillingness of letting strangers to gain partial control of the firm. An example was the Nanyang Brothers' Tobacco Company, a large and successful company competing with British counterparts in coastal China. As one of the very few registered firms using the new corporate model, they chose the share-holding ownership structure as the last resort to raising equity capital, and tried their best to minimize the control stakes of anyone outside of the founder's family.²

Historically, China did not use the legal system in commerce, but it had a highly commercialized society. The earliest form of capitalism can be traced back to the late Ming Dynasty (17th century), with commerce initiated in the Zhejiang-Jiangsu area and further developed during the Qing Dynasty (17th century to early 20th century). The Opium War (1840s) between China and Great Britain ruined China's sovereignty, but it brought Western-style legal and capital systems into China's coastal areas (until 1949). During this period, foreign systems and the Chinese system co-existed and commerce boomed. Despite the entrance and development of Western-style courts in Shanghai and other major coastal cities, most business-related disputes were resolved

² For more descriptions of China's financial system see AQQ (2005b, 2008). For more anecdotal evidence on the development of China's financial system in the same period, see, for example, Kirby (1995) and Lee (1993).

outside courts. Since the Qing Dynasty, dispute resolution by guilds (merchant coalitions), families, and local notables based on the detailed regulations of guilds, family traditions, and customs was commonplace. Chinese firms on the mainland (pre-1949) and later in Taiwan (after 1949) did not use the provisions of the law but again conducted commerce outside the legal system. Modern equivalents of these dispute and contract enforcing mechanisms are arguably behind the success of Chinese firms in the 1980s and 1990s.

The development of China's financial system from the late nineteenth century to the early twentieth century was highlighted by the emergence of Shanghai as the financial center of China and Asia. Shanghai transformed from an agricultural-based trading hub for surrounding areas into an industrialized center linked to international goods and financial markets. With thriving entrepreneurial and trading activities, financial institutions proliferated and financial innovations surged. For example, the number of Chinese lending institutions (*qianzhuang*) exceeded 105 in 1875; five of China's first modern banks were founded between 1897 and 1908; and by 1936, there were 28 major foreign banks that had set up branches in Shanghai. Merchants used up to eleven currencies in their transactions, some of which were printed by local banks; the exchange rate of local currency saw wide fluctuations; many unregistered local banks (*diaotang*) engaged in high-leverage credit transactions with little capital reserves and defaulted frequently. At the same time, merchants' fear of risk spawned an active insurance industry, which was first introduced by the British. Insurance on real estate, ships, and goods became routine, with collateral and personal guarantors accompanying large transactions to reduce the risk of non-payments; to alleviate the problems of asymmetric information, foreign merchants hired Chinese middlemen (and guarantors) to select Chinese merchants. Chinese and foreign merchants also devised the "commission indent system," an early form of trade credit allowing firms and institutions to operate with minimum financial resources. The stock exchange in Shanghai was the largest in Asia for most of the 1920s

and 1930s. It is worth mentioning again that most of the development of the sophisticated financial system coincided with one of the most volatile periods in Chinese history characterized by political turmoil and (civil and foreign) wars.

A review and comparison of India's corporate sectors also provide an example of the effectiveness of alternative mechanisms and problems with formal institutions. The Indian economy is unbalanced relative to other emerging economies in that 52% of output is from services, 26% is from manufacturing and 22% is from agriculture (67% of workforce). Manufacturing industries have not done well perhaps because they are constrained by unions and traditional political economy factors including corruption and bureaucracy in the government and legal system. New industries like software have done much better because they are not constrained by political economy factors and rely more on alternative mechanisms. ACDQQ (2008) have conducted detailed surveys of more than 200 firms from the Small- and Medium Enterprises (SMEs) sector in India, and the results clearly favor alternative mechanisms over the law and legal system.

For example, when asked about their preferred actions if they face defaults, breaches of contract and dispute initiated by their business partners or customers, over 80% of surveyed firms say they do not use the legal system at all. Informal, out-of-courts channels of dispute resolution play a far more important role for these firms. About 50% of the firms surveyed do *not* have a regular legal adviser; among the other half that does, less than 50% of these firms have "legal advisors" with a law degree or a license to practice law. When pressed for a reason, 63% of respondents who did not have legal advisors claimed they did not need lawyers as they knew all their business partners and could deal with them fairly. Clearly, the formal legal system takes a back seat while reputation, trust and informal personal relationships are the driving factors in screening counter-parties to do business with.³

The inverse of reliance on law that determines whether a firm seeks legal recourse to redress a

³ However, the courts, while not the most popular method of dispute resolution, appear to have some utility as a negotiating tool. When asked what a firm does to ensure payment or repayment (more than one response allowed), about 59% replied that they would go to court while leaving negotiation possibilities open.

breach of contract and other disputes is concern for legal deterrence that may prevent it from perpetrating similar breaches itself. To this end the survey findings indicate that legal sanctions are far less important than the demands and responsibilities of the informal networks within which they exist and function. For instance, in the case of default, late payment and a breach of contract, the primary concern is loss of future business opportunities or reputation; the fear of legal consequences (adverse court sentence or jail term) is the *least* important concern, below even threat to personal safety.

Overall, the picture that emerges of the SME sector in India clearly indicates that the sector has little confidence in the legal system. It relies little on the courts in settling disputes and enforcing contracts and is also not much concerned about legal consequences of infractions. Non-legal sanctions, on the other hand, are far more effective. This is also the finding of the Chinese corporate sectors today. One common theme of China and India is that by operating outside the legal system, corporate sectors, especially small and medium nonlisted firms and their investors and customers can minimize the costs of using institutions such as financial markets and banks. In Section III below we compare more carefully the alternative mechanisms, such as reputation, connections and networks and positive financial incentives, with legal mechanisms, in terms of assuring performance and other ‘good’ behaviors.

II.2 Intellectual Property Rights and Innovations

This is one of the ‘hot-button’ issues in both legal and economic research and practice. Due to space limitations we cannot obviously review all the evidence. We focus on two aspects of the protection of intellectual property rights. First, whether the protection of exclusive rights (through patents, copyrights, trade secrets, trademarks, etc) has a positive impact on the pace of innovation, and second, the advantages and disadvantages of using the law and legal institutions as the basis for disputes related to intellectual property rights.

In most countries and certainly in the U.S., the scope of patentable subject matter has

traditionally *not* included fundamental scientific discoveries. A frequently mentioned rationale for this omission is that many scientists care little for monetary rewards, and would pursue the discoveries in any case. To grant patent awards for purely scientific discoveries would then be socially wasteful. On the other hand, after the patent is applied for and approved and issued, the primary forum for resolving disputes is the (federal) courts, which have exclusive jurisdiction over disputes involving the infringement of patents, as well as over appeals of court decisions.

The background on patents begs the question of what kind of inventions are protected by patents and the relative importance of innovation that are protected by patents and those that are not. In this regard, Table 2 presents the history of some of the major medical breakthroughs during the past 150 years. It is interesting to see that the majority (especially before 1950) of the discoveries were made by university researchers (not affiliated with corporations) and the initial invention was not protected by any patents. In some of the cases the patent holder is not the original inventor or discoverer.

As an example the process of discovering and producing penicillin is illuminating. While widely believed to be discovered by Alexander Fleming (as shown in Table 2), in 1928, several others had discovered its bacteriostatic effects as early as 1875.

The real challenge of the new ‘wonder drug’ was how to produce it in large quantities. This period coincided with WWII, during which penicillin made a significant difference in deaths and amputations caused by infected wounds among Allied forces. Due to the large demand and problems with technologies of mass production, the price soared in the markets and a large amount was reserved for military use. A team of British and American scientists led by Nobel Laureates Howard Florey and Norman Heatley finally made the breakthrough in the early 1940s. Penicillin production was quickly scaled up and made available in quantity to treat Allied soldiers wounded on D-Day. As production rose, the price dropped from being nearly priceless in 1940, to \$20 per

dose in July 1943, to \$0.55 per dose by 1946. Andrew Moyer, a member of the research team, was granted a patent in the U.S. for a method of mass production of penicillin in May of 1948, after the commercial value of the drug had plummeted. Interestingly, other researchers and producers of penicillin had applied for patents in other European countries but the applications were turned down, as it was deemed ‘unethical’ to provide exclusive rights for an invention that can save lives. In fact, the attitude of governments and societies toward using patents and copyrights became increasingly pro-rights holders only after World War II.⁴

There is an extensive literature in industrial organization in economics examining the relationship between patent/copyright protection and the pace of innovations, and the research yields mixed findings (e.g., see proceedings from OECD 2005 reports on intellectual property rights and competition). While exclusive property rights provide strong incentives for innovations and do lead to more innovations in some industries such as chemicals and pharmaceuticals (and there are significant cross-sectional differences across industries and countries), excessive protection deters competition, another important factor in spurring innovations. In addition, based on changes in patent laws and enforcement regulations, Lerner (2003, 2005) only finds weak or no evidence that strengthening patent rights and enforcement spur the pace of innovations across most developed countries.

China is often singled out as one of the countries that is notoriously bad in protecting intellectual property rights, as copying and imitation via reverse engineering is a prevalent strategy across industries. For example, Chinese car Chery QQ appeared six months before the Chevy Spark which it was a copy of, and the Shanghuan Automobile’s CEO model is remarkably similar to a

⁴ For example, Thomas Jefferson, a prolific inventor and founding father of the U.S. Constitution, was known for his suspicion of granting monopoly power to inventors (‘no patent for ideas’). As Secretary of State, he also held the post as Examiner of American Patents, and insisted on thorough examination of the originality and novelty of an invention applying for patents. During the second half of the 19th Century, an effective abolitionist movement, which promoted free trade and competition and viewed patents as part of an anti-competitive and protectionist strategy analogous to tariffs on imports, paused the process of adoption of patent laws in European countries. In particular, the Netherlands repealed its patent legislation in 1869 and did not reinstate the patent system until 1912 (e.g., Khan, 2005).

BMW X5. Legal actions by foreign firms have been nearly useless in preventing these activities. Perhaps a saying in Shanghai best summarizes the social norm toward copyrights protection: “We can copy everything except your mother...” While the protection of intellectual rights in China has been poor, apparently the pace of innovations has been furious at the same time due to the pressure of competition.

One of the main problems with the patent system and using the law and legal system as the basis of protecting intellectual property rights is that it motivates rent-seeking behaviors by interest groups. One of the well-known problems in the patent system is that companies, especially large corporations with abundant resources, come up with numerous *nonessential* ‘inventions’ to ‘pad’ the one significant (patented) invention or establish a new ‘standard’ in production (e.g., Dewatripont and Legros 2007). This problem is particularly important when the creation of a standard requires the use of many different technologies (in the case of mobile technology, for instance, a handset can require the use of more than a thousand technologies protected by patents.) By jamming the patent system with these extra patents these companies can essentially block or delay innovations by competitors. This is what has led to the FRAND concept – “fair, reasonable and non-discriminatory royalties.”

Another form of rent-seeking behavior is that patent holders, especially those with more resources, seek the best possible legal venue to maximize the likelihood of winning a lawsuit against patent or copyright infringements. This type of behavior runs directly against the principal that the legal system within a democracy should be based on fair procedures and allow equal access to all. The fast rise of Marshall, a small town in eastern Texas, the self-proclaimed Pottery Capital of the World and home to the annual Fire Ant Festival (e.g., *New York Times*, 9/24/2006), as the center of patent-related litigation is an interesting case study. According to LegalMetric, a legal data and analysis company, the Federal Eastern District of Texas (which also includes the rural

towns of Tyler and Texarkana), now handles the largest amount of patent litigation cases (up to one third of all new cases and an even higher fraction of all cases involving a US firm suing foreign firms or individuals) in the country, surpassing courts in Chicago, Manhattan, and even the Central District of California (in Los Angeles), historically home to the largest number of new patent cases.

Some attribute the popularity of the Texas district to the efforts of the locals to streamline the process of patent litigation including adoption of uniform rules. Most observers, however, attribute this phenomenon to one person, T. John Ward, the federal judge in Marshall, Texas. He became interested in patent law while defending Hyundai Electronics against a lawsuit by Texas Instruments; Hyundai lost and Texas Instrument was awarded \$25.2 million in 1999. Since Ward joined the Eastern District of Texas, the district has seen a tenfold increases in patent cases since 1999 (14 cases in 1999, and 234 in 2006). Judge Ward has been described as pushing cases through quickly, and his court has been described as a “rocket docket” for its speed. His trial rules include strict timetables and the use of a chess clock to time opening and closing arguments. Each side in a case might receive between 9 and 15 hours for evidence, compared to other courts which it may take a month or more.

There is disagreement as to whether the jurors from the district are “patent friendly.” Judge Ward himself has described the district as historically “plaintiffs oriented,” and the Marshall jury pool as “defenders of property rights” and “friendly to patent owners’ interests.” Some claim that plaintiffs, especially US firms suing foreign firms and individuals over patent infringements, often have an advantage because they hire Marshall lawyers or legal consultants who know the jurors and benefit from that information. Whether the alleged court’s friendliness toward patent holders is true or not, the fact is that plaintiffs (patent holders) have won much more frequently (and have done so in a short period of time no less) in the district than anywhere else in the country.

II.3 Limited Capacity of Legislature

One of the potential problems of using the legal system is that, when there are fundamental changes in an economy so that the law and/or regulation must be revised, the legislature must approve any revisions before corporations and investors can freely implement new techniques in their transactions and interactions (without worrying about breaking the law). However, politicians have limited time and effort that can be devoted to any given area of the law, and hence there is a legislature capacity and a fixed cost in revising the law. The following example illustrates that such limited capacity and fixed costs can single handedly slow down pace of innovations and transactions in practice.

Figure 1 compares payments systems in major developed economies. At the start of the 21st Century the U.S. had a 19th Century payments system, relying mostly on checks and the mail, and significantly lagging behind other developed nations. For example, while countries like Germany, the Netherlands, Sweden and Switzerland have almost completely abandoned checks (and rely instead on electronic payments systems) as a method of payments, about half of all the payments within in the U.S. were still in the form of checks. Checks had to be physically transported from where they were deposited to a central operations center, then to the clearer and then back to the banks they were drawn on. This check-and-clearing process significantly delayed business transactions as compared to electronic methods.

How costly was this backward payment system? Using information from Humphrey et al. (1996) and Bolt et al. (2005), we can conduct the following ‘back-of-the-envelope’ calculations. From cross-country comparisons and analysis, these researchers suggest that there are saving of 1-2% of GDP when a country moves away from paper checks (e.g., the U.S.) and towards electronic-based methods. From Table 1, the U.S. 2007 GDP was \$13,543 billion, which indicates the magnitude of savings from reforming the payment system to be \$135billion to \$270billion per year.

With a 5% discount rate (roughly the risk-free rate in the U.S.), the discounted present value of this savings (assuming perpetuity) is between \$2.7 trillion to \$5.4 trillion; in other words, the magnitude of the savings is higher than that of the most recent Iraqi war.

Despite years of calls for changes from the banks and businesses, the U.S Congress appeared not in a hurry to solve this seemingly simple yet costly problem. Without the approval of the legislature banks cannot implement any significant changes due to the fear of lawsuits. Then September 11, 2001 acted as a catalyst for change. After the terrorist attack all commercial flights in the U.S. were grounded for several days, completely halting the check clearing process. After the flights resumed the call for change was finally heard by the Congress. The Check Clearing for the 21st Century Act was signed in October 2003, which allows electronic images to be a substitute for the original checks and thus the clearing process is no longer dependent on the mail and transportation system.

II.4 Impact of Patent Protection on Recent Internet-based Innovations

There are recent innovations communications and knowledge industries based on internet technological revolutions that have made fundamental changes to many people's lives or have the potential to do so. In the knowledge front, SSRN (Social Science Research Network) and JSTOR are great academic inventions that bring new working paper and published articles, in digital and electronic format, to individual researchers worldwide essentially free of charge (based on institutional subscriptions). For the general public, Wikipedia, a multilingual, web-based platform with free content, is quickly becoming the most useful encyclopedia. Written collaboratively by volunteers from around the world, the Wikipedia articles provide links to guide the user to related pages with additional information and a great point to start researching almost any subject (including the materials for this article!). Since its creation in 2001, it has grown rapidly into one of

the largest reference websites attracting over 600 million visitors annually by 2008.

While the growth of Wikipedia has met with little resistance from the traditional media companies, it is a totally different situation with Google's equally ambitious "Print and Library Project." It has two components, Google Publisher Program, in which a publisher controlling the rights in a book can authorize Google to scan the full text of the book into Google's search database, and Google Library Project, where some of the largest libraries (Harvard, Oxford, and Stanford Universities, the University of Michigan, and New York Public Library) allow Google to scan materials into a search database. According to the initiatives from Google, for books/print materials in the "public domain" (not subject to copyright) from the libraries, Google will display the full text of the book with the search result; for those that are still covered by copyrights, readers can only see a few sentences of the text around search item. Copyright holders can also exclude selected books from Google Print. The benefits for readers/online users are obvious, and for a lot of authors this project is also a free marketing device.⁵

Ever since the initial idea of the Project floated around, it was met with disdain from the traditional publications companies. The Association of American Publishers, including firms such as Penguin, McGraw-Hill, Pearson Education, Simon & Schuster and John Wiley & Sons, and the Authors Guild, the nation's largest organization of book authors, filed suits against Google in the second half of 2005 (despite the objection of many authors whose books were published by the companies). The legal action came after months of talks failed to hammer out an agreement and has held up the implementation of the project indefinitely. Even if Google wins in the U.S. they may be sued again in other countries (e.g., in EU countries) with different and perhaps even more stringent copyright laws. Google's primary legal defense: Fair use doctrine under the U.S. Copyright Law.

Another example is the Linux operating system, started in 1991 by Linus Torvalds. A Unix-

⁵ For example, Stanford library holds 9 million volumes of "Orphan Works," or books/print materials that are still in copyright but out of print with virtually no continuing commercial viability.

like computer operating system, Linux is one of the most prominent examples of free software and open source development. Typically all underlying source codes can be freely modified, used and redistributed by anyone. Historically, Linux has mainly been used as a server operating system, and has risen to prominence in that area.

How does Linux stack against the Windows system, the most prominent operating system released under a proprietary software license by Microsoft? Not surprisingly, Windows dominates the desktop and personal computer markets with about 90% of market share, as compared to 1% market share by Linux. The distribution techniques used (e.g., through bundling with other softwares such as Internet Explorer) by Microsoft are well known and the firm has been accused of using its monopoly power to take advantage of smaller companies. In the servers market, Windows had a share of 36% (fourth quarter of 2007) while Linux had a share of 12.7%. As of November 2007, Linux powered 85% of the world's most powerful supercomputers; in February 2008, Linux powered five of the ten most reliable internet hosting companies. Proponents of free software argue that the key strength of Linux is that it respects what they consider to be the users' essential freedom, the freedom to run, study and change, and to redistribute copies with or without changes free of charges.⁶

Our final example regards music (and movie) downloads, both legally and illegally, and the status of the music (movie/entertainment) and recording industries. Downloading music first became popular with the file sharing technologies such as peer-to-peer networks, with individuals possibly knowingly or unknowingly violating copyright laws by not obtaining permission or payments. The Recording Industry Association of America (RIAA) claims that this practice is

⁶ Nobody registered the name *Linux* till August 1995, when William Della Croce, Jr., applied for a trademark and demanded royalties from Linux distributors. Mr. Torvalds and other affected organizations sued him to have the trademark assigned to Torvalds, and the case was settled in 1997. Mr. Torvalds has repeatedly stated that he only trademarked the name to prevent others from using it, but was bound in 2005 by US trademark law to take active measures to enforce the trademark. As a result, the Linux Mark Institute, holder of the name, had to request a fee be paid for the use of the name and a number of companies have complied.

damaging the music (and entertainment) industry, and a series of lawsuits led to many of these networks (with perhaps the best known example of Napster between 1999 and 2001) being shut down. Going after companies such as Napster is one thing, going after millions of people downloading and sharing music on a daily basis is another. However, RIAA and the recording companies are certainly trying.

Recently, the RIAA and industry has taken its crusade against pirating one step further: In its federal case against Jeffrey Howell, a Scottsdale, Arizona man who kept a collection of about 2,000 music recordings on his personal computer, the industry maintains that it is *illegal* for someone who has *legally* purchased a CD to transfer that music into his own computer (*Washington Post*, 12/30/2007). Interestingly, researchers (e.g., Oberholzer-Gee and Strumpf 2007) have found that internet music piracy not only does not hurt legal CD sales, it may even boost sales for some types of music. The researchers, using 1.75 million downloads over 17 weeks in 2002 and comparisons with the sales of 700 albums, found that most illegal downloading is done over peer-to-peer networks by teenagers and college students. These groups are “money poor but time rich,” meaning they would not have purchased the songs they downloaded and hence the industry cannot claim those downloads as lost record sales. On the other hand, illegal downloading may actually help the industry slightly with many “samplers” – an older crowd who downloads a song or two and then, if they like what they hear, go out and buy the music.⁷ One way or the other, many observers of the industry believe that RIAA’s campaign against its own customers is a classic example of an old media company clinging to a business model whose time is in the past.

There are numerous additional examples of abusing the patent system (e.g., see Bessen and Meurer 2008 for more details). The ordeal Edwin Armstrong (affiliated with Columbia University)

⁷ The industry is also in dispute with Apple over iTunes, now the largest retailer in music (surpassing Wal-Mart stores). The Universal Music Group of Vivendi, the world’s largest music corporation, notified Apple recently that it will not renew its annual contracts to sell music through iTunes (*New York Times*, 07/02/2007). One of the industry’s main complaints is Mr. Steve Jobs (founder and CEO of Apple)’s strong stance on the uniform pricing rule of 99 cents per song, a strategy that abandons price discrimination and would hurt sales according to the industry.

had to endure to win his patent rights of inventing FM radio against RCA and other prominent traditional radio companies back in the 1920s and 1930s, and the long (recently resolved) dispute between Research in Motion, maker of the Blackberry handheld device, against NTP, a patent holding company, are a few noted examples.

We end this subsection with a comment on the effectiveness of using lawsuits (by interest groups) to protect copyrights. As in the case of music downloads, the efforts by interest groups seem to be largely ineffective when the public is engaged in the illegal act at low costs, but these efforts become more effective when a single company is leading the implementation of new technologies (e.g., Google's Print Project). The contrast in these cases however suggests that using the law as the basis for the protection of intellectual property rights can induce rent-seeking behavior by the interest groups that will have the most to lose given the new technologies, and their efforts can become significant barriers to changes and innovations.

II.5 Alternative Mechanisms can work in Complicated Transactions

We provide two examples here to demonstrate that alternative mechanisms operating outside the legal system can deal with complicated transactions. First, the diamond industry has historically operated outside the legal systems (e.g., Bernstein 1992). In fact, the global diamond industry has systematically rejected state-created laws. This is in part due to the fact that legal contracts cannot be enforced since the value of each transaction (a particular diamond) is highly idiosyncratic and most diamond traders do not have access to capital markets, and hence calculated damages based on "what if" contingencies are not applicable. Moreover, it takes too long to get a resolution from courts. In its place, the sophisticated diamond traders (belonging to trading clubs or bourses) who dominate the global industry have developed an elaborate, internal set of rules, complete with distinctive institutions and sanctions, to handle disputes. The arbitration process within the DDC

(diamond dealers club) based on the rules is usually straightforward and quick, with ruling often involving parties simply splitting the differences in estimated damages. Typically, the private arbitration system keeps all judgments secret as long as payments are promptly paid. Given the long-term relationship of members and reputation effect, these simple rules work much better in the long run (even though they may not be fair in individual cases) and save costs. In recent years, the World Association of Diamond Bourses (WFDB) has successfully shifted from the traditional relationship-based DDCs to world-wide information technology based regime (database on reports of arbitration from 20 plus member countries, many of which in Asia). In their discussions about the reform rarely does a country's laws come up.

Another industry that has relied on out-of-court mediations and arbitrations to settle disputes is reinsurance. In the most widely accepted sense, reinsurance is understood to be the practice where an original insurer, for a definite premium, contracts with another insurer or insurers, to carry a part or the whole of a risk assumed by the original insurer. While the earliest reinsurance contract can be traced to the 14th Century Italy (e.g., Kopf 1929), the first use of an arbitration clause in an insurance contract was, by most accounts, the one in the insurance Company of North America in 1793 (e.g., Winn 2004). This system has both parties appointing their own arbitrators and usually has the two party-appointed arbitrators appointing a third arbitrator referred to as an 'umpire.' In practice, however, it is the parties and their outside counsel who play a large role in the selection of the umpire. This often results in disagreements, especially in large transactions, which delays the appointment and hence arbitration process.

In recent years the industry has been revising the traditional procedure in order to expedite the process without losing sight of fairness. Industry experts point to other industries where arbitration has been used most successfully. One such example is securities arbitration, where the rules are disseminated by the New York Stock Exchange and the National Association of Securities

Dealers and are continually refining and improving (e.g., Kondo 2007). The Dispute Resolution Protocol, which is non-legally binding for members, developed by the Conflict Prevention & Resolution International Industry, reflects these new ideas and changes. Based on best practices from the field, the Protocol, among other things, simplifies and standardizes the process of selecting neutral arbitrators, and has been endorsed by leading companies such as Lloyd's. This example demonstrates the importance of adapting to changes quickly as a main condition for the long-term viability of a dispute resolution mechanism.

III. Legal Institutions vs. Alternative Mechanisms: Comparisons and Policy Implications

Based on the above examples, we now compare the advantages and disadvantages of conducting commerce based on the law and legal system vs. alternative mechanisms outside the legal system. Given the advantages and disadvantages of either system, we then derive conditions under which one of the two systems is superior. Finally, we provide discussions on policy implications based on our analysis.

III.1 Comparing Legal and Alternative Mechanisms

There are well-known advantages of using the law and legal system as the basis for commerce. The legal system in a democracy allows equal and full access by all and promises fairness in trials and settlements. Backed by the government and legislature, the legal system also has the ultimate authority in its decisions on any and all disputes. The legal system is also endowed with powerful enforcement mechanisms, including criminal penalties, such as imprisonment, as well as civil laws and financial penalties to affect people's behavior. These enforcement mechanisms and penalties provide strong incentives for all agents to follow the resolutions endorsed by the legal system, which in turn provides long-term stability in the economy. The legal process

including enforcement can be anonymous (e.g., details of a settlement of disputes (instead of trial) in many cases are rarely made public) or transparent (e.g., details of high-profile trials are publicly announced and covered in media). By using the entire legal operator and system, the marginal enforcement costs can be very low and this improves overall efficiency.

However, there are also disadvantages in using the legal institutions as basis for commerce. First, recent research on political economy factors, and in particular, work by Rajan and Zingales (2003a,b) argues that rent-seeking behaviors by vested interest groups can turn legal institutions into barriers to changes. We expect these problems to be much more severe in developing countries and the costs of building good institutions can be enormous in these countries. We argue that one way to solve this problem is not to use the law as the basis for commerce but instead to use alternative mechanisms. Second, in democracies there can be a lengthy political process before significant changes can be approved (by the majority of entire population and/or legislature), and the people in charge of approving or disapproving changes (e.g., politicians and judges) may lack the expertise of business transactions and have limited capacity (time and effort) to examine the proposed changes. The approval process of the Checking Clearing Act of the 21st Century in the U.S. above is a good example on this capacity. In addition, as discussed in examples above interest groups with more resources may receive more protection than individuals and this asymmetric protection system induces more rent-seeking behaviors and further deters innovations.

Unlike the legislature which has monopoly power and authority in defining and revising the law, one of the main advantages for alternative mechanisms is that it is more likely to have competition among different mediation/resolution agencies/organizations. The process of competition can ensure that the most efficient mechanism will prevail, which includes having only experts involved in the rule-changing process. Competition can also limit rent-seeking behaviors by one or more groups. Clearly, alternative mechanisms can be much faster in adopting new rules to

deal with changes in commerce since these changes do not require the permission from the legislature or electorate.

One of the main disadvantages of the alternative mechanisms is their lack of enforcement power. Without the backing of the government and/or judicial system, alternative mechanisms can only rely on reputation along with economic and financial incentives (e.g., avoiding future losses due to sanctions by other members of the network resulting) and self-enforcing, implicit contractual agreements. These methods may not be sufficient to ensure good behaviors if future losses are not substantial (relative to the gains can be made today) and/or if these losses can be partially recuperated by entering other lines of business or networks. Another setback for alternative mechanisms is that by design they exist among a network (or networks) and thus are inaccessible to outsiders; a partial access by outsiders may come with the price of biased outcomes in dispute resolution favoring insiders. In addition, frequent changes adopted by a network (or networks) create instability and hence weak long-term incentives.

These advantages and disadvantages lead to the tradeoffs of using the law and courts vs. alternative mechanisms in different economic environments. In *static* environments with infrequent (and predictable) changes (i.e., mature and slow-growing economies and industries), the advantages of the legal mechanisms dominate their disadvantages. First, the strong incentives that can be provided by the enforcement of the legal system imply that efficient systems can be designed that do not rely solely on positive monetary incentives. Second, the fixed costs of using the legal system can be negated by the infrequent revisions of the law and by large scale transactions; also the legislature and the judicial system can appoint experts (and judges) to be involved with the process of changing the law and regulations and grant them with the authority in decision making. The above two factors also imply that there is stability in the system, which in turn creates long-term incentives for economic agents to ‘play by the (universal) rule.’

In *dynamic* environments with frequent (and unforeseen) shocks (i.e., emerging, fast-growing economies such as China and India), however, the disadvantages of the legal mechanisms are magnified and outweigh their advantages. The lengthy approval process by the legislature and electorate of any changes to the law, along with the lack of expertise by the judges and politicians, means that the legal system is slow in reacting to changes. Moreover, a legal system captured by interest groups can in fact oppose changes, and given its monopoly power it can become a barrier to competition and innovations. On the other hand, alternative mechanisms can adapt to changes much more quickly, since competition ensures that the most efficient mechanism will be implemented quickly. Weak enforcement power and long-term incentives of the alternative mechanisms are complemented by effective reputation mechanisms as long as there are long-term profits to be made and shared by economic agents.

The interaction between legal and alternative mechanisms is another reason why alternative mechanisms can improve social welfare. Since most of the laws are adopted from ‘best practice,’ having a viable system of alternatives can thus improve the efficiency of legal institutions, especially in dynamic environments. Competition among formal and alternative mechanisms can also ensure that the best mechanism will be eventually adopted in the entire economy, and this is especially important in environments where special interest groups can easily capture the legal system. A fair and functional legal system can also improve the effectiveness of alternative mechanisms by adopting the best rules and enforcing the changes in the entire economy and by instilling stability amid frequent changes.

III.2 Policy Implications

It is not our intention to downplay the importance of the role of the law and legal system in commerce. Our ultimate goal is to help design the optimal combination of formal and alternative

institutions that best suit a country's needs. To this end we have compared the advantages and disadvantages of legal institutions versus alternative mechanisms. We conclude that legal mechanisms are an important part of developed economies' institutions, providing stability and strong long-term incentives. This conclusion is based on the premises that there are infrequent shocks to the economy that cause fundamental changes in ways of how business is done, that the legal system allows full access by all and promises fair resolution of disputes and enforces the rules uniformly.

Unfortunately, these assumptions making the legal institutions the optimal system in developed countries are likely to hold in most emerging economies. A fast-growing economy, such as China and India and a growth phase that most developing countries will go through, is often characterized by frequent changes to the fundamentals of the economy, making frequent changes to how business is done a requirement, not a choice. Given that it typically takes years to build a well-functioning legal system and other formal institutions, the fixed costs of using the legal system can be quite high in a dynamic economy, even if the system provides fair and expertise in dealing with changes. A perhaps much more severe problem with the legal system is the political economy factors. It would be much easier for interest groups to capture the legal system and government in a country with underdeveloped institutions than in a country with developed institutions. As a result, an economy relying on the law and legal institutions as the sole basis for commerce may end up being the barrier for changes and innovations.

Therefore, we argue that alternative mechanisms play a much more prominent role in emerging economies, and can actually be superior to legal mechanisms in supporting business transactions in certain industries or entire economies. Our main policy implication is that in emerging economies alternative dispute resolution and contract enforcement mechanisms should be encouraged and developed alongside the development of legal and other formal institutions. In

particular, measures that help foster competition and reduce entry barriers are welfare enhancing. The coexistence of and competition between alternative and legal mechanisms can also exert positive impact on the development of legal institutions, so that they are less likely to be captured by interest groups and become more efficient in adapting to changes. Whether and how a transition from a system dominated by alternative mechanisms to one using the law and legal institutions as the focal point depends on the country's economic history and growth potentials, as well as the workings of many other social and cultural factors that help build the social norms in the society and business communities.

IV. Summary and Concluding Remarks

In our view China and India's economic success contains important lessons. While using the law in finance and commerce has become a widely accepted idea, it is based on the history of institutional development in the West. We have argued that it can be optimal in static environments with infrequent changes. In dynamic environments such as China and India it may be better to use other mechanisms that do not rely on the law because this reduces the inefficiencies associated with political economy factors. Designing economic institutions that minimize political economy problems by not relying on the legal system is one of the keys to fast economic growth.

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Table 1 The Largest 20 Economies in the World: GDP and Growth

GDP in 2007 (simple exchange rates)			GDP in 2007 (PPP)		GDP growth: 1990-2007 (constant prices)		Per capita GDP growth: 1990-2007* (constant prices)	
Rank	Country /Region	US\$ billion	Country /Region	Int'l \$ billion	Country /Region	Annual growth	Country /Region	Annual growth
1	U. S.	13,794	U. S.	13,543	China	10.3%	China	9.3%
2	Japan	4,346	China	11,606	Vietnam	7.6%	Vietnam	6.0%
3	Germany	3,259	India	4,727	India	6.3%	Korea	4.7%
4	China	3,249	Japan	4,346	Malaysia	6.2%	Taiwan	4.5%
5	U. K.	2,756	Germany	2,714	Chile	5.6%	India	4.4%
6	France	2,515	U. K.	2,271	Korea	5.5%	Chile	4.2%
7	Italy	2,068	France	2,040	Taiwan	5.3%	Poland	3.9%
8	Spain	1,415	Brazil	2,014	Bangladesh	5.2%	Sri Lanka	3.8%
9	Canada	1,406	Russia	1,909	Sri Lanka	5.0%	Malaysia	3.7%
10	Brazil	1,295	Italy	1,888	Yemen, R.	5.0%	Thailand	3.6%
11	Russia	1,224	Spain	1,310	Thailand	4.6%	Bangladesh	3.1%
12	India	1,090	Korea	1,250	Pakistan	4.6%	Indonesia	3.0%
13	Korea	950	Mexico	1,250	Egypt	4.5%	Peru	2.9%
14	Australia	890	Canada	1,217	Iran	4.5%	Iran	2.9%
15	Mexico	886	Indonesia	1,054	Peru	4.4%	Argentina	2.8%
16	Netherlands	755	Taiwan	750	Indonesia	4.4%	Egypt	2.3%
17	Turkey	482	Australia	731	Turkey	4.0%	Turkey	2.3%
18	Belgium	443	Turkey	723	Argentina	4.0%	Pakistan	2.3%
19	Sweden	432	Argentina	691	Poland	3.9%	Spain	2.2%
20	Switzerland	414	S. Africa	664	Philippines	3.8%	Australia	2.2%

Notes: *: Countries with population less than 20 million or GDP less than US\$ 20 billion are excluded from this ranking.

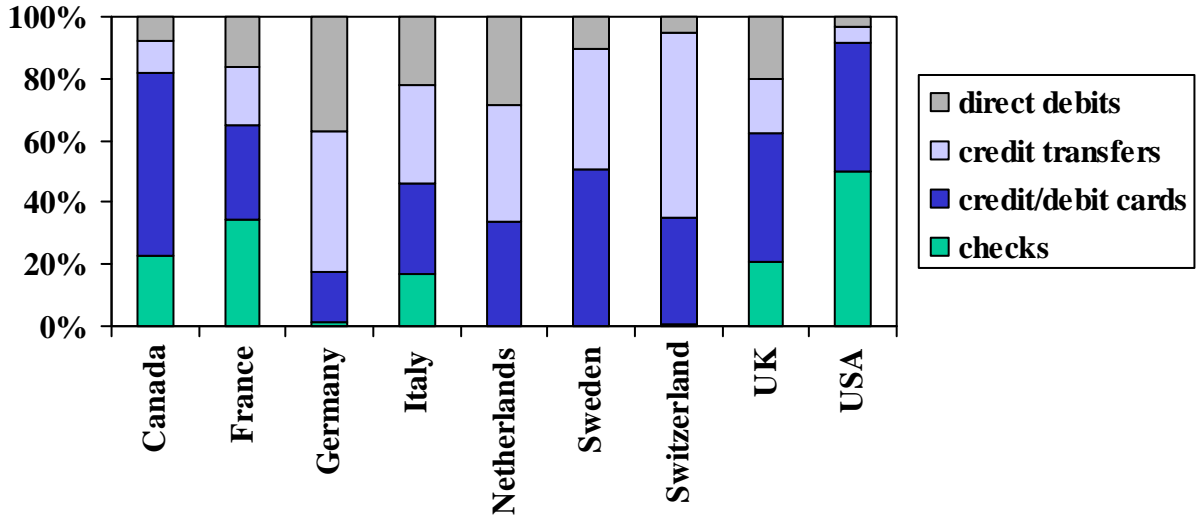
Source: IMF World Economic Outlook Database 2008.

Table 2 Major Medical Inventions and History of Patents

Name	Purpose of Use	Inventor	Invention Time	Have a patent?	Patent Holder	And When?
Ophthalmoscope	Instrument used to examine the eye	Charles Babbage	1847			
		reinvented: Hermann von Helmholtz	1851			
		refined: William Allyn & F. Welch	1915	US Patent: 4065208	Welch Allyn	1915
Hypodermic needle	A hollow needle used with a syringe to inject substances into the body	Charles Pravaz & Alexander Wood	1853			
		Disposable syringes: Arthur E. Smith	1949-1950	8 US Patents	Arthur E. Smith	1949-1950
		Disposable syringes: Phil Brooks	9-Apr-74	US Patent	Phil Brooks	9-Apr-74
		Hypodermic needle: K. Simm & D. Emis	31-Aug-04	US Patent	K Simm & D Emis	31-Aug-04
Carbolic acid (phenol)	sterilize surgical instrument to clean wounds	Joseph Lister		US Patent: 1950359		
Rabies vaccination	To prevent rabies (viral neuroinvasive disease)	Louis Pasteur	Jul 6, 1885	No		
Contact Lens	A corrective, cosmetic or therapeutic lens	Descriptions of lenses: Leonardo da Vinci	1508			
		Corneal contact lens: Rene Descartes	1632			
		Water-filled glass tube with lens: T. Young	1801			
		Invented and made: Adolf Eugen Fick	1887			
		Grinding to fit eye's surface: John Herschel	1827			
		US made plastic lens: W. Feinbloom	1936			
		Plastic lens: Kevin Tuohy	1948			
		Soft and gas-permeable lens	1970s			
X-ray	Used for diagnostic radiography	Wilhelm Conrad Rontgen	Nov 8, 1895			
Electrocardiogram	Graphic produced by an electrocardiograph of the electrical activity of the heart	String galvanometer: Willem Einthoven	1901	US Patent: 4457309	Elmeskog; Alf U.	Feb. 1982

Sphygmomanometer	A device used to measure blood pressure	R. H. Miller	1948	US Patent: 2560237	R. H. Miller	10-Jul-51
		Pocket sphygmomanometer: Man S. Oh	2002	US Patent: 6752764	Pocket: Man S. Oh	22-Jun-04
Penicillin	Treatment of bacterial infections	Sir Alexander Fleming	28-Sep-28	US Patent:	Andrew J. Moyer	25-May-48
Artificial pacemaker	A electrical device to regulate heart beating	Earl Bakken & C. Walton Lillehei	1957	US Patent: 4009721	Alcidi; Mario	23-Apr-76
Heart Transplant	Procedure for patients with heart failure or severe coronary artery disease	Christiaan Barnard	Dec, 1967	No		
MRI & fMRI	Imaging technique primarily used in Radiology	Paul Lauterbur & Peter Mansfield	1970	US Patent	R. Damadian	1974
CAT scan	Medical imaging using tomography	Godfrey Newbold Hounsfield Allan Mcleod cormack	1967-1972	US Patent: 3922552	Robert S. Ledley	25-Nov-75
Ultrasound scan	An ultrasound-based diagnostic imaging	Lan Donald	1953-1958	US Patent: 5860925	D. Liu; (conversion)	27-Jun-97
Artificial Heart	Prosthetic device implanted to replace heart	Robert Jarvik	1970's-1980's	US Patent: 3097366	Paul Winchell	16-Jul-63

Figure 1 Comparing Payments Systems in Developed Countries



Source: Bank for International Settlements, "Statistics on Payment and Settlement Systems in Selected Countries," March 2006, www.bis.org/publ.