

Classifying Exchange Rates

By Kurt Schuler

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SUMMARY

At present no coherent, comprehensive, generally accepted scheme for classifying exchange rate arrangements exists. This paper offers such a scheme and thereby improves our understanding of how various arrangements work. Among other things, the ideas of the paper clarify why some arrangements are more crisis-prone than others. The scheme of classification this paper proposes differs from many existing schemes by:

- Separating the monetary authority (the “who” of a monetary system) from the exchange rate (one of the “whats”).
- Recognizing that the less convertible the currency, the less distinction exists among different degrees of nominal flexibility.
- Classifying exchange rate arrangements in a two-dimensional triangular field, whose dimensions are nominal flexibility and convertibility, instead of a series of compartments having only one dimension, nominal flexibility.
- Distinguishing between managed and unmanaged exchange rates.
- Paying attention both to official words and to *de facto* deeds.
- Explicitly recognizing that multiple exchange rates are hybrid arrangements that often should not be classified as being only one type of rate. This remark applies to arrangements where more than one exchange rate exists either officially or unofficially.

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1. NO GENERALLY ACCEPTED SCHEME OF CLASSIFICATION EXISTS

An exchange rate arrangement is the terms on which people may exchange domestic currency for foreign goods, including currency, financial assets, and precious metals. Until the 1970s, economists typically classified exchange rate arrangements as either fixed (also termed pegged) or floating (also termed fluctuating or flexible). Sometimes there was also an intermediate category for arrangements that allowed substantial but limited fluctuations. This two- or three-category classification dominated textbooks and the International Monetary Fund's annual report on exchange arrangements.

The breakdown of the Bretton Woods system in the early 1970s led to wide use of exchange rate arrangements that were previously rare. Classifications added categories to accommodate the new reality, but not in a uniform way that found general acceptance. Within the last several years a new trend has added further complexity: research has shown that it has been common for *de facto* exchange rate arrangements to differ from officially stated arrangements.

Box 1 shows ten recent schemes for classifying exchange rate arrangements. Eight are from studies of *de facto* exchange rate arrangements. Another scheme is that of the IMF, which in the last ten years has moved largely but not completely from official to *de facto* criteria for classification. The current IMF scheme, in use since 1999, seems to be the most common scheme mentioned in textbooks that go beyond two- or three-category classifications. The last scheme is that of Jeffrey Frankel, which unlike the others has not so far been the basis for an empirical study.

A glance at the box reveals one problem that has beset researchers: lack of a uniform terminology. Another problem is frequent disagreement across studies on how to classify particular cases. For example, a pairwise comparison of three *de facto* classification schemes found that they agreed with the IMF classifications in only 41 to 55 percent of cases, but they agreed with each other even less—in just 35 to 45 percent of cases. The IMF classified Egypt as having a managed float with multiple exchange rates from August 1989 to January 2001. Carmen Reinhart and Kenneth Rogoff term the *de facto* exchange rate a crawling band to the U.S. dollar to October 1991 and a hard peg thereafter. Eduardo Levy-Yeyati and Federico Sturzenegger term the *de facto* exchange rate a dirty float to 1991, inconclusive from 1992 to 1997, a fix in 1998, inconclusive in 1999, and a float in 2000.¹

Such wide variations in results indicate that we lack a coherent and comprehensive scheme for classifying exchange rate arrangements. Without such a scheme, we cannot usefully interpret historical experience with exchange rate arrangements, analyze current arrangements, or comment on proposed arrangements.

¹ The pairwise comparison is in Frankel (2003, p. 39), from a table by Marina Halac and Sergio Schmukler that compares Ghosh and others (1996), Levy Yeyati and Sturzenegger (2000), and Reinhart and Rogoff (2002). See also Dubas and others (2005, p. 24). Classifications for Egypt are from various issues of the International Monetary Fund's *Annual Report on Exchange Arrangements and Exchange Restrictions*, Levy-Yeyati and Sturzenegger (2002, a later version of the work Frankel cites), and Reinhart and Rogoff (2004, also a later versions of the work Frankel cites).

Box 1: Classification schemes

Within each scheme, categories are listed from least to most flexible in terms of nominal exchange rates.

De facto classifications

Bubula and Otker-Robe (2003) (13 categories): Another currency as legal tender; currency union; currency board; conventional fixed peg to single currency; conventional fixed peg to basket; pegged within a horizontal band; forward looking crawling peg; forward looking crawling band; backward looking crawling peg; backward looking crawling band; tightly managed floating; other managed floating; independently floating.

Dubas, Lee, and Mark (2005) (6 categories): Currency peg; limited flexibility; cooperative arrangements; adjusted according to a set of indicators; managed floating; independently floating.

Ghosh, Gulde, and Wolf (2002) (10 categories): Monetary union, dollarization, currency boards, single currency peg, basket peg, cooperative regimes, crawling peg, target zones and bands, managed floating, float.

Kuttner and Posen (2001) (a matrix resulting in 39 possible categories, with a different emphasis than most other schemes): Exchange rate regime (4 categories): currency board; hard peg; target zone/crawl; float. Domestic policy (5 categories): currency board; narrow money target; broad money target; inflation target; none. Central bank autonomy (3 categories): none; partial; full.

Levy-Yeyati and Sturzenegger (2002) (5 categories): Fixed; crawling peg; dirty float; flexible; inconclusive.

Nitithanprapas and Willett (2002) (5 categories): Hard fixed; narrow band sticky pegs; crawling bands/pegs; heavily managed float; lightly managed float.

Reinhart and Rogoff (2004) (14 categories): No separate legal tender; preannounced peg or currency board arrangement; preannounced horizontal band that is narrower than or equal to +/-2%; *de facto* peg; preannounced crawling peg; preannounced crawling band that is narrower than or equal to +/-2%; *de facto* crawling peg; *de facto* crawling band that is narrower than or equal to +/-2%; preannounced crawling band that is wider than or equal to +/-2%; *de facto* crawling band that is narrower than or equal to +/-5%; noncrawling band that is narrower than or equal to +/-2% (i.e., allows for both appreciation and depreciation over time); managed floating; freely floating; freely falling (includes hyperfloat). Reinhart and Rogoff also note multiple exchange rates.

Stone and Bhundia (2004) (8 categories, with a different emphasis than most other schemes): Monetary nonautonomy; exchange rate peg; full-fledged inflation targeting; implicit price stability anchor; inflation targeting lite; weak anchor; money anchor.

Mixed official / de facto classification

International Monetary Fund (since 1999) (9 categories): Exchange arrangements with no separate legal tender; currency board arrangements; other conventional fixed peg arrangements (against a single currency or against a composite); pegged exchange rates within horizontal bands; crawling pegs (within a cooperative arrangement or other); exchange rates within crawling bands; managed floating with no preannounced path for the exchange rate; independent floating. The IMF also notes multiple exchange rates. (The IMF also classifies monetary policy into 5 categories: Exchange rate anchor; monetary aggregate target; inflation targeting framework; Fund-supported or other monetary program [ceilings for net domestic assets or floors for international reserves]; other.)

A classification not so far used for empirical work

Frankel (2003) (9 categories): Monetary union; dollarization; currency board; adjustable peg; basket peg; crawling peg (including indexed peg and preannounced crawl); band (including target zones and constant nominal central parity); managed floating; free floating.

2. MONETARY SYSTEMS VARY WIDELY

Consider the monetary systems the following countries have.²

- Panama has no central bank, no locally issued paper money (people use U.S. dollars instead), and no significant exchange controls.³
- The United Arab Emirates has a central bank that maintains an official exchange rate of 3.67275 dirhams per U.S. dollar, and it has no significant exchange controls.
- The Central Bank of the Solomon Islands calls its exchange rate a basket, while the IMF calls it a peg to the U.S. dollar. In practice, the central bank has maintained an exchange rate of around 7.50 Solomon Islands dollar per U.S. dollar since October 2002. Exchange controls exist for current and capital transactions.
- North Korea's central bank maintains a main official exchange rate of 150 won per dollar, although the euro is the official anchor. Multiple other effective rates exist. Comprehensive exchange controls permit no market where private parties can legally trade large amounts of foreign currency.
- Vanuatu's central bank links the vatu to a basket of currencies whose composition is secret. No exchange controls exist.
- The IMF calls Argentina's exchange rate a managed float, but in practice, the central bank has generally maintained the peso within a band of 2.75-3.10 per dollar since March 2003. Exchange controls exist for capital transactions.
- The European Central Bank maintains what the IMF calls an independent float, with no significant exchange controls, for its member countries. It rarely intervenes in the foreign-exchange market. The central bank targets inflation in consumer prices of below, but close to, 2 percent a year, which it supports by setting reference values for growth in M3.
- Japan's central bank also maintains what the IMF calls an independent float. Until March 2004 its central bank intervened often in the foreign-exchange market. The central bank has no explicit target for monetary policy, although in practice it keeps inflation low.

These cases illustrate features that a discussion of monetary systems should take into account. (Later sections discuss which of these features a classification of exchange rate arrangements should include, and which should be left to other classifications.) The monetary authorities are national central banks for most countries, a multinational central bank for the members of the

² Information here is mainly from the 2006 edition of the IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions*, except that information on North Korea is mainly from Korea Institute for International Economic Policy (2004, p. 72). IMF (2006) suggests some changes to the IMF's scheme of classifying exchange rate arrangements.

³ Panama does issue coins and has a distinct unit of account, the balboa, which is equal to the U.S. dollar, but its government has not used these features to promote any independence in monetary policy.

European Central Bank, and no domestic monetary authority in Panama, which is fully dollarized. Their exchange rates vary from having no nominal flexibility to full flexibility. Their anchors vary from a single currency to a basket to explicit targets for inflation to no explicit target. In the Solomon Islands and Argentina, the *de facto* exchange rate arrangements differ from the official arrangements. Exchange controls among the cases vary from nonexistent to comprehensive. The level of discretionary intervention in the foreign-exchange market varies from none in Panama and the European Central Bank countries to almost daily in Argentina; North Korea is a case apart because exchange controls prevent a true foreign-exchange market from even existing. Among the central banks, some have a high degree of autonomy in setting exchange rate policies, while others have little or no independence. North Korea's central bank and commercial banks are under unified state control as components of a centrally planned economy, whereas all the other countries have independent, privately owned commercial banks.

3. SEPARATE “WHO” FROM “WHAT”

Before delving further into exchange rate classification, it is worthwhile to take a step back and see where exchange rate arrangements fit within the broader scheme of monetary systems. A monetary system is the set of practices determining who may issue the monetary base and credit, and on what terms. The following components cover the major technical features of monetary systems:

The monetary authority: Who issues the monetary base, and under what constraints?

The monetary base: What constitutes the monetary base? (The monetary base is the medium accepted for final settlement of payments in the local financial system; in other words, it is what banks typically use for clearing.)

The monetary standard: What rules or actions determine the value of the unit of account in which the monetary base is expressed? (Exchange rate arrangements enter here, as does the relationship between exchange rates and targets such as the rate of inflation.)⁴

Financial regulation: Who issues the various types of credit that form broader measures of the money supply, and what determines the nominal magnitude of that credit?

This way of viewing the components of monetary systems separates the exchange rate from the monetary authority. A monetary authority is a government-sanctioned body that issues a country's monetary base. The monetary authority is one of the “whos” a monetary system, while the exchange rate arrangement, as part of the monetary standard, is one of the “whats.”

Some of the classification schemes in Box 1 contain categories for currency boards and for no separate legal tender (or its components monetary unions—also called currency unions—and dollarization). These schemes mix the “who” with the “what” of monetary systems in a way that can be confusing. They place currency unions, dollarization, and currency boards at the rigid end of the scale of nominal flexibility because a currency union by definition has a rigid exchange rate internally. Historically, dollarized systems and currency boards have also almost always had rigid rates, but a classification scheme should acknowledge that they might operate with more flexible rates. The Kurdish areas of northern Iraq continued to use old Iraqi dinars, known as

⁴ Mason (1963, pp. 39-40, 105-6), Dowd (1996, pp. 311-13), and Bordo (2003) contain discussions of the monetary standard. They arrive at different classifications than this paper does.

“Swiss print” dinars, after in effect seceding from the rest of the country during the 1991 Persian Gulf War. The largest denomination of the currency was demonetized in the rest of the country in 1993, but it continued to be generally accepted in the Kurdish areas and had a floating exchange rate with more recently printed Iraqi dinars until a currency reunification in October 2003.⁵ It is also possible to imagine a variant of a currency board that would have a crawling exchange rate. The currency could depreciate at a uniform rate of, say, 0.01 percent per day, as a way of generating increased seigniorage. No such system has yet existed in practice, but a system of classification should be flexible enough to leave room for it. As for monetary unions, they are neither a type of monetary authority nor a type of exchange rate arrangement. Rather, they are the joint operation of a monetary authority and the sharing of a unit of account across borders.⁶ A monetary union has a rigid exchange rate internally, but may have any kind of exchange rate externally, and it can exist under various monetary authorities.

Moreover, all the classification schemes that include a category for currency boards include some systems that do not belong. Currency boards have long been understood as being monetary authorities that passively issue notes and coins (and deposits, if any) fully convertible into an anchor currency at a predetermined exchange rate. To insure a passive, nondiscretionary monetary policy, currency boards have typically held net foreign reserves equaling 100 percent or slightly more of the monetary base and have held no significant domestic financial assets. The definition of a currency board the IMF has used since 2003 agrees with this understanding.⁷ The IMF and other observers have classified as currency boards Bosnia, Brunei, Bulgaria, Djibouti, Estonia, Hong Kong, Lithuania, and the members of the Eastern Caribbean Central Bank today, plus Argentina’s “convertibility system” of April 1991 to early January 2001. Using the IMF’s *International Financial Statistics*, a look at the balance sheets of the monetary authorities in question shows that some have piled up net foreign reserves far in excess of 100 percent of the monetary base, while Argentina’s net foreign reserves were often well below 100 percent; all except Bosnia have held domestic assets; and most have engaged in extensive sterilized intervention, which is a form of discretionary monetary policy.⁸ These systems, other than perhaps Bosnia and in recent years Estonia, have at times behaved much differently from orthodox currency boards, which were the predominant type until the 1990s. Failure to

⁵ Foote and others (2004, pp. 61-2). A similar episode occurred in the Democratic Republic of the Congo in the mid 1990s. Notes demonetized in provinces under the control of the central government continued to be used in rebel provinces. Rebel provinces thereby avoided the much of the inflation that afflicted government-controlled provinces (Banque Centrale du Congo 1997, pp. 165-7).

⁶ A broader use of the term “monetary union” includes cases where countries adopt equivalent units of account and perhaps allow circulation of notes and coins across borders, but retain separate monetary authorities. Examples include the Latin Monetary Union and the Scandinavian Monetary Union, both of which began in the late 1800s and in effect ceased in 1914.

⁷ “Currency board arrangement: A monetary regime based on an explicit legislative commitment to exchange domestic currency for a specified foreign currency at a fixed exchange rate, combined with restrictions on the issuing authority to ensure the fulfillment of its legal obligation. This implies that domestic currency will be issued only against foreign exchange and that it remains fully backed by foreign assets, eliminating traditional central bank functions such as monetary control and lender-of-last-resort, and leaving little scope for monetary policy. Some flexibility may still be afforded, depending on how strict the backing rules of the currency board arrangement are” (International Monetary Fund 2003a, p. 2). Before 2003, the IMF’s definition included only the first sentence. The old definition was too vague to distinguish currency boards from some central banks. For most of its first 60 years, the U.S. Federal Reserve System was bound by a legislative obligation to a gold standard and required to hold certain minimum ratios of gold reserves to ensure that it would fulfill the obligation, but it was not a currency board.

⁸ Hanke (2002).

understand the differences between these “currency board-like” systems and orthodox currency boards has had important consequences. Towards the end of the Argentina’s convertibility system, most debate about whether Argentina should change its exchange rate arrangement failed to understand that Argentina already had a discretionary monetary policy characteristic of central banking rather than a nondiscretionary policy characteristic of a currency board.

4. INCORPORATE CURRENCY CONVERTIBILITY

The dimensions of a good that economists typically consider when analyzing markets are price, quantity, and, less often, quality. In the foreign-exchange market, price is the exchange rate—for our purposes here, the nominal exchange rate. Quantity is a measure of the nominal supply of money. Usually the monetary base is most appropriate for the purposes here, because it is the measure most directly under the control of the monetary authority. Broader measures of the supply of money, which include various kinds of credit, are related to the monetary base through the base being the medium for final settlement of credit obligations. Quality is the extent of currency convertibility—the ability to trade the currency without legal impediments. Each dimension is a channel through which the supply of domestic money can adjust, or fail to adjust, to demand in the foreign-exchange market. Adjustment can occur in one dimension only or through a combination of dimensions. Alternatively, government policies may block adjustment in one or more dimensions. Lack of convertibility is always the result of exchange controls imposed by the government; remove the controls and people will trade the currency at whatever exchange rate clears the market. In each dimension, differences may exist between what a government claims to be the case and what exists in practice.⁹

Simple textbook accounts of exchange rate often focus only on the degree of nominal flexibility of the exchange rate, and neglect other features that in practice have great importance. Many also continue to recognize only two degrees of flexibility, fixed and floating. For the country cases above, a simple textbook account would lump together Panama, the United Arab Emirates, and North Korea as fixed rates and the remaining cases as floating rates. Doing so is plainly unsatisfactory, because important differences exist in the way the systems work. Imagine you are a resident of one of the countries with “fixed” rates and you wish to obtain U.S. dollars. In Panama, you already have them in your wallet. In the United Arab Emirates, you can exchange your dirhams for dollars at a bank with no trouble. In North Korea, the only place you can readily exchange won for dollars is the parallel market, where you face imprisonment or worse if caught. (A parallel market can range from officially approved to possibly illegal but tolerated to definitely illegal and persecuted; in the last case it is often called a black market.)

These examples show how much currency convertibility influences the way exchange rate arrangements work. Persistent differences in convertibility among currencies have existed since the outbreak of the First World War in 1914, when modern exchange controls first became widespread. (Previously, many countries restricted the export of gold and silver, but effective restrictions on capital movements through transfers of credit seem to have been rare.) Bringing currency quality into the analysis of exchange rate arrangements helps us to understand

⁹ The question of which currency or commodity is the exchange-rate anchor does not enter into the analysis at this level. Links to gold, silver, the U.S. dollar, and the Russian ruble have important similarities in the way they work despite big long-term differences in the behavior of the anchors.

differences that are important in practice. For example, when Argentina began a managed float in February 2002, exchange controls gave rise to an exchange rate in addition to the official rate. This parallel rate, reported in the newspapers of the period, was officially illegal, but the government expended little energy to suppress it. Exchange controls also gave rise to schemes to evade controls by using loopholes between the stock market and other financial markets.¹⁰ Floating rates without exchange controls do not have parallel markets and therefore do not experience parallel market premiums.

Just as there are multiple systems for classifying exchange rates, there are multiple systems for classifying convertibility. For many years the IMF's summary of convertibility in the appendixes to its *Annual Report on Exchange Arrangements and Exchange Restrictions* simply noted whether a country had or did not have current-account and capital-account convertibility. The implicit result was four categories: full convertibility, current-account convertibility only, capital-account convertibility only (rare), and neither current- nor capital-account convertibility. The IMF also noted whether countries belonged to payments unions and similar arrangements. Some researchers¹¹ have developed scales that discriminate more finely, and in recent years the IMF has increased the detail in its summaries of convertibility. As with exchange rate flexibility, the important thing from the standpoint of economic theory is to recognize that in principle, convertibility is spectrum, ranging from full to inconvertible. In practice, it is possible to group observations into categories that are useful for historical understanding, but the number of categories and their precise content may vary depending on the purpose of particular research.

Of the classification schemes in Box 1, only Reinhart and Rogoff incorporate exchange controls directly. Most schemes ignore exchange controls, though Levy-Yeyati and Sturzenegger have an "inconclusive" category, and note that exchange controls are one factor that can prevent the data they use from yielding clear results.¹² The IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions* contains detailed information on exchange controls, but fails to make the crucial final step of remarking how exchange controls can make a *de facto* exchange rate arrangement quite different from the official arrangement. Where Reinhart and Rogoff have data, they note episodes of parallel exchange rates, which are the most useful single gauge of whether exchange controls have an effect on behavior in the foreign-exchange market. They also offer rough estimates of the volume of transactions occurring at the main official rate, other official rates, and the unofficial parallel market rate. The range of textbook treatments is similar to the range of treatments in Box 1. Only a few textbooks give exchange controls much prominence, and even then, not in proportion to their worldwide prevalence in the last 100 years.¹³

5. THINK IN TWO DIMENSIONS, NOT ONE

In light of the considerations we have just reviewed, the logical organizing principle for classifying exchange rates is the channels of adjustment of supply and demand in the foreign-exchange market. To repeat, adjustment can occur through price (the exchange rate), quantity (the monetary base), or quality (convertibility). Figure 1 below offers a way of representing the

¹⁰ Auguste and others (2003).

¹¹ Quinn (2003), Miniane (2004), Edwards (2005); Edwards also gauges the effectiveness of exchange controls.

¹² Levy-Yeyati and Sturzenegger (2002, p. 16 n. 46).

¹³ For example, Pugel (2004, pp. 493-6).

channels of adjustment in a diagram. A number of other writers have presented the triangle diagram before in connection with exchange rates, but have not exploited it to full advantage. In particular, some have thought in terms of the borders of the triangle and not considered using the interior as a field for classifying exchange rate arrangements. Both nominal flexibility of the exchange rate and convertibility are best thought of as spectrums. Between the extremes of rigid and flexible exchange rates, and between full convertibility and total inconvertibility, it is possible to devise as many intermediate gradations as one might wish, by making small changes.¹⁴

The figure includes references to a distinction between managed and unmanaged exchange rates. A later section of this paper discusses the distinction and argues for its importance. However, it is possible to use the classification scheme in the figure even if you consider the distinction between managed and unmanaged rates unimportant.

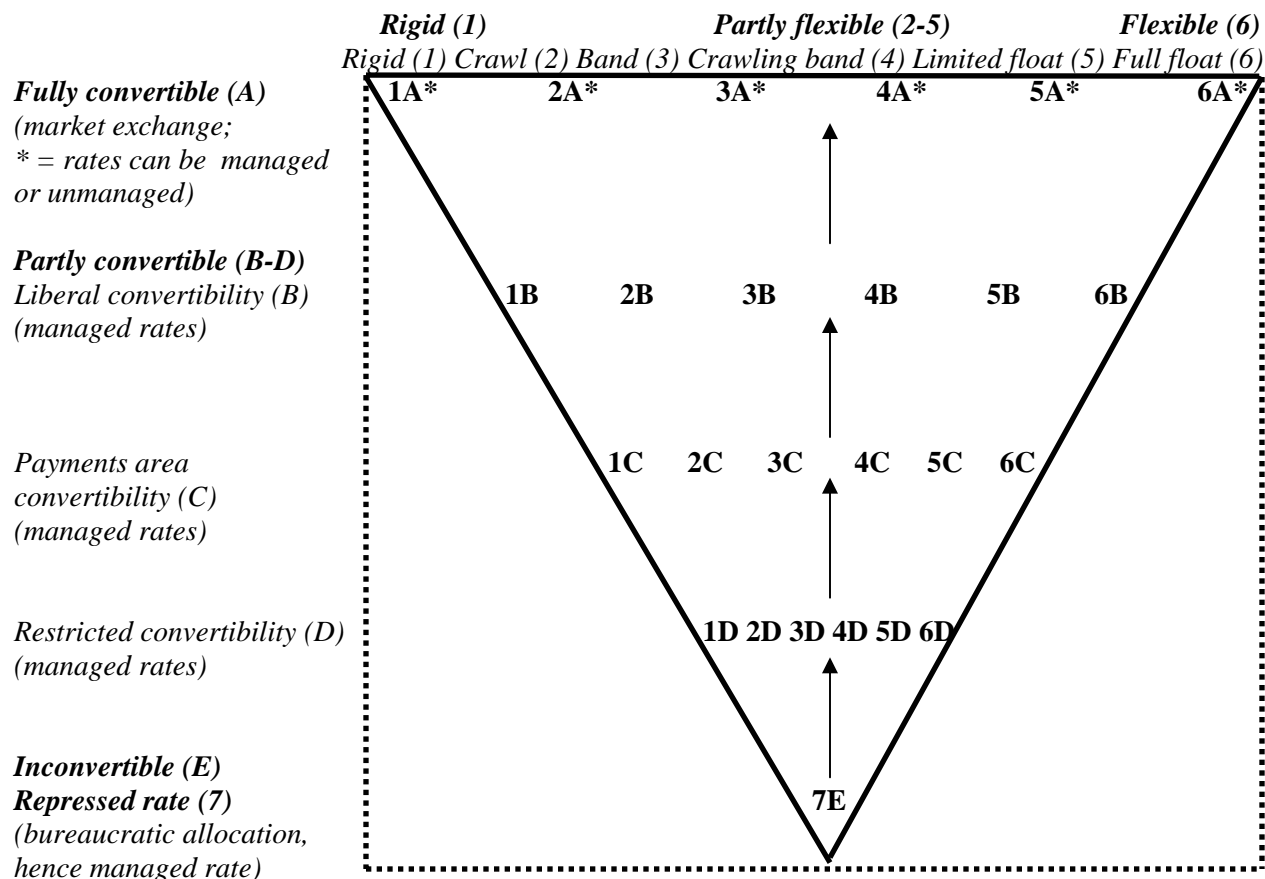
(Main body of text resumes on page 12.)

¹⁴ This paper stresses channels of adjustment between the supply of and demand for foreign currency that operate directly through the foreign-exchange market, but there are also channels that operate indirectly, such as tariffs, quotas, export subsidies, advance deposit requirements, tradable import or export licenses, certain government-regulated auction systems in foreign trade or foreign exchange, and foreign borrowing. On import controls and their effects, see Austin (1992).

Some readers may ask where interest rates fit in the scheme of adjustment, since most central banks today use an interest rate as their immediate target. Typically, targeting the interest rate is a way of regulating the growth of the monetary base to a rate the central bank hopes is consistent with the level of inflation or the exchange rate it desires to maintain. If the target interest rate is too high, commercial banks do not borrow from the central bank and the monetary base grows so slowly that inflation is lower than the central bank desires or the nominal exchange rate experiences pressure to appreciate. If the target interest rate is too low, commercial banks borrow extensively from the central bank and the monetary base grows so fast that inflation is lower than the central bank desires or the exchange rate experiences pressure to depreciate.

T. Ashby McCown has suggested to me that institutional factors affect how the channels of adjustment work. In a country where currency depreciations have been frequent, depreciation may trigger a further fall in demand for money, whereas in a country whose currency has tended to retain value, depreciation may trigger an increase in demand for money because people expect a return to a more appreciated exchange rate. The idea is worthy of a longer treatment than it can receive here.

Figure 1. A proposed classification for exchange rate arrangements



Notes to figure above

This scheme can be used for official (*de jure*) or actual (*de facto*) classifications. Arrows indicate that without an intrusive bureaucracy to enforce them, exchange controls tend to break down over time as people find ways around them. Over the long run, the bottom corner of the triangle therefore tends to move up, narrowing the range of options. The narrowing of the field from a line at the top to a point at the bottom indicates that as exchange controls become more restrictive, supposedly distinct exchange rate arrangements work increasingly alike. Rather than being within the dashed lines of the rectangle, they are within the solid lines of the triangle. On managed versus unmanaged rates, see the main text below.

Source: The first use of a diagram like this for exchange rates seems to be Aglietta (1988). The first use in a published work seems to be Oxelheim (1990, p. 10), who developed the idea independently. Frankel (1999, p. 7) seems to have been the first to insert an arrow.

Notes to classifications below

Nominal flexibility and convertibility are spectrums. Sometimes it may be hard to tell whether one arrangement is more flexible or convertible than another. Rigid rates may have as their anchor a single currency (or commodity), two or more currencies in alternation (as bimetallism was often in practice alternating monometallism), or a basket of currencies in predetermined proportions. Cooperative combinations are possible: the reference grid of the European Monetary System was such a combination of pegs and bands. Multiple exchange rates can work as combinations of arrangements below the top row.

Horizontal axis: nominal flexibility of the exchange rate

- 1 Rigid:** The exchange rate is a horizontal band with margins of fluctuation not exceeding 2 percent total (the maximum the IMF allowed members under the Bretton Woods system), and typically not exceeding +/-1 percent around the central rate. An unmanaged rigid rate is called a fix; a managed rigid rate is called a peg. Examples: Panama (uses U.S. dollar, so fixed), United Arab Emirates (pegged to U.S. dollar).
- 2-5 Partly flexible:** The exchange rate has a predictable nonzero trend or has margins of fluctuation exceeding 2 percent total.
- 2 Crawl (backward- or forward-looking):** The exchange rate follows a nonzero trend (usually depreciating) against a single currency or a basket, with margins of fluctuation not exceeding 2 percent total. I call an unmanaged crawl just that; a managed crawl is called a crawling peg. Example: Costa Rica (crawling peg to the dollar).
- 3 Band:** The exchange rate is a horizontal band with total margins of fluctuation between 2 percent and 30 percent. (The margin of 30 percent, though somewhat arbitrary, indicates that beyond certain limits, bands become ineffective in practice). I call bands unmanaged or managed. Example: Hungary (managed band with the euro).
- 4 Crawling band:** The exchange rate follows a nonzero trend (usually depreciating) against a single currency or a basket, with total margins of fluctuation between 2 percent and 30 percent. I call crawling bands unmanaged or managed. Example: Belarus (*de facto* managed crawling band with the Russian ruble, though officially pegged to the ruble).
- 5 Limited float:** No durable margins of fluctuation exist, but the monetary authority intervenes to create temporary floors or ceilings, such as by limiting daily volatility. This category includes bands not exceeding 30 percent that lack readily identifiable trends. I call an unmanaged limited float just that; a managed limited float is called simply a managed float. Example: Japan (managed float, at least until March 2004).
- 6 Flexible: full (independent) float:** No set level, even temporary, for the exchange rate. An unmanaged full float is called a clean float; I call a managed full float a free float. Examples: New Zealand (clean float since 1985); Canada (occasionally intervenes in the foreign-exchange market, hence a free float).
- 7 Repressed:** No true legal market in foreign exchange exists, so the officially stated degree of flexibility has little bearing on the exchange rates at which transactions actually occur. Example: North Korea.

Vertical axis: convertibility

- A Fully convertible:** No significant exchange controls exist, so the government does not ration foreign exchange. Exchange rates can be managed or unmanaged.
- B-D Partly convertible:** Some exchange controls exist, typically resulting in multiple official rates or a parallel market. Exchange controls involve managed exchange rates.
- B Liberal convertibility:** Convertible for current-account or (less often) capital-account transactions, but not both. Example: Bolivia. This category also includes situations which, besides the liberal convertibility that applies generally, have full convertibility for a limited set of transactions. Current-account convertibility in practice often allows a considerable degree of capital movement through leads and lags in payments, or through misstating the value of goods paid for.
- C Payments area convertibility:** Exchange controls apply to current- and capital-account transactions alike, but participation in a payments union yields liberal or full convertibility with an important set of trading and investment partners. Example: Western European currencies in the 1950s that were part of the European Payments Union, which provided for something approaching current-account convertibility within the payments area, but not with the rest of the world.
- D Restricted convertibility:** Exchange controls apply to current- and capital-account transactions alike, but something of a market in foreign exchange exists. Example: Somalia.
- E Inconvertible:** Comprehensive exchange controls, involving a managed exchange rate. Example: North Korea.

The corners of the triangle represent the three channels through which adjustment can occur in the foreign-exchange market. At the top are exchange rate arrangements that have full convertibility. Full convertibility as defined here means that exchange controls do not significantly impede the adjustment of the exchange rate or the monetary base. The U.S. dollar is fully convertible, but the United States imposes exchange controls on transactions with certain countries hostile to the United States and with certain groups that support terrorism. The controls are not significant for the exchange rate of the dollar and are not meant to be. Similarly, for currencies with rigid exchange rates, exchange controls may exist with third currencies, as they did from 1940 to 1979 for countries that used the pound sterling as their anchor currency. “Sterling area” countries had a common set of exchange controls applying to transactions with countries outside the area. The controls hampered adjustment of the sterling area with the rest of the world, but did not hamper adjustment within the sterling area.

In the top left-hand corner is a rigid rate. With it, the channel by which supply adjusts to demand in the foreign-exchange market is the nominal monetary base, whose relation to broader measures of the supply of money was mentioned above. In the top right-hand corner is a fully floating exchange rate. With it, the channel by which supply adjusts to demand in the foreign-exchange market is the nominal exchange rate. Between the corners in the top row are exchange rates that are partly flexible, fluctuating within determinate limits with respect to an anchor currency.

Potentially, the field is a rectangle, indicated by the dashed lines. In practice, as exchange controls become more restrictive, supposedly different exchange rates work more and more alike. Figure 1 indicates the narrowing of possibilities by narrowing the field from a line at the top to a point at the bottom, placing the range of actual exchange rate arrangements within the solid lines of the triangle rather than within the rectangle. In the bottom corner of the triangle is an exchange rate that is completely inconvertible, that is, no market exists on which the currency can be traded. No accepted term exists for such a rate. Call it a “repressed” rate, to echo the term “financial repression,” which the work of Ronald McKinnon and Edward Shaw brought into use.¹⁵ Other possible terms are “administered,” “bureaucratic,” “controlled,” or “dictatorial.” If the comprehensive controls of a repressed exchange rate are successful, no market-based channel of adjustment exists because there is no true foreign-exchange market, just a government monopoly to allocate foreign exchange. The channel by which supply adjusts (or fails to adjust) to demand in the system of foreign-exchange allocation is bureaucratic decisions to ration foreign exchange, rather than market exchange.

The usual practice of governments that have maintained repressed exchange rates has been to mimic a rigid rate by keeping the main official rate unchanged in terms of an anchor currency for long periods. They could just as easily alter the main rate daily, mimicking a flexible rate. Because nobody can trade at the official rate without government permission, changes in a repressed rate need have no relation to the foreign-exchange transactions that actually occur.¹⁶

¹⁵ McKinnon (1973), Shaw (1973).

¹⁶ Also, repressed rates have usually involved multiple exchange rates that often change. The exchange rate a state owned enterprises receive in foreign trade can also change often, despite an unchanging main official rate.

The argument for adding a second dimension to exchange-rate classification and recognizing repressed rates as a distinct variety is that adjustment of the supply of foreign exchange to the demand can and often does occur through bureaucratic allocation as well as through markets. In some countries, almost nobody may do business at the official rate, whereas in others, everyone may and does. Since the start of the First World War, almost all countries have had periods in which exchange controls and the accompanying bureaucratic allocation of foreign exchange were significant. Centrally planned economies have had comprehensive exchange controls for decades. Going beyond the one-dimensional classification of exchange rates as more or less nominally flexible acknowledges both an important theoretical possibility and a pervasive historical reality.

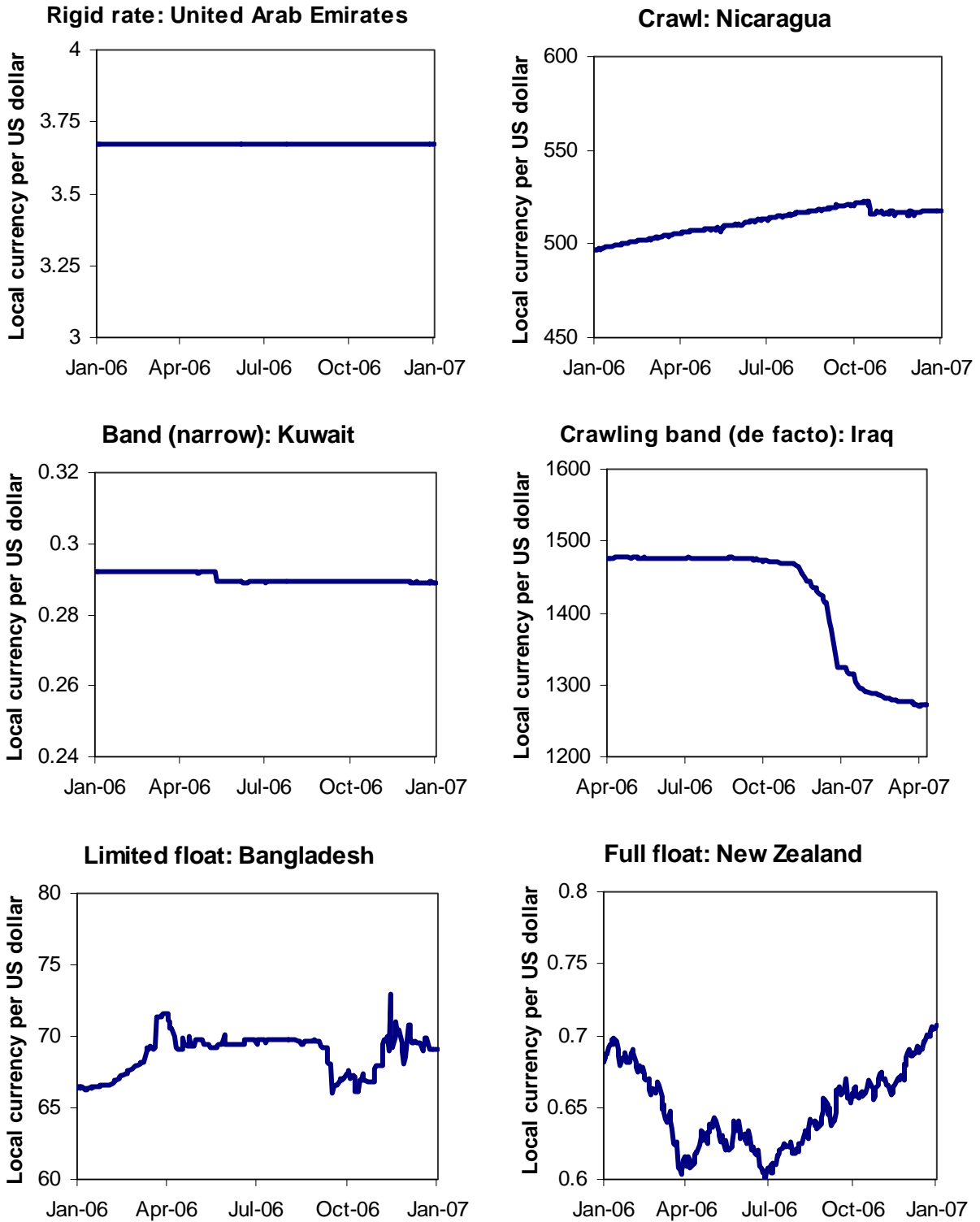
Exchange controls offer the prospect of avoiding adjustment through the monetary base or the exchange rate. Over time, though, exchange controls tend to break down as people find ways to evade them and earn profits from the difference between the official exchange rate and the parallel market rate. Preserving the effectiveness of exchange controls tends to require the bureaucracy enforcing them to become increasingly intrusive. The bottom corner of the triangle in Figure 1 therefore tends to move up, narrowing the range of options. The arrows in the triangle are reminders of this tendency. A repressed rate is at the bottom of the triangle to indicate that it is the least efficient of the three consistent exchange rate arrangements, because it adjusts through bureaucratic fiat rather than through markets.

A few other points about Figure 1 merit note. The first is that sometimes it may be hard to say if one arrangement is more flexible or more convertible than another. The scale of nominal flexibility focuses on average daily flexibility, but over time, a crawling band of +/-5 percent around the central rate may allow the nominal exchange rate to vary more than a stationary band of +/-10 percent around the central rate. Some exchange controls may seem highly restrictive but may be easily evaded by legal or illegal means. The second point, which is related, is that intermediate degrees of flexibility between the left- and right-hand corners of the triangle and intermediate degrees of convertibility between the top and the bottom of the triangle are spectrums, but for practical purposes it is useful to divide the field into a number of compartments (“buckets”). The compartments are based on considerations of analytical simplicity and historical prevalence, but coarser or finer divisions are possible. The third point is that Figure 1 approaches exchange rate classification from a defensible but narrow logic of internal consistency. It therefore downplays wider considerations such as the possible economic and political costs of an exchange rate that fluctuates “too freely.”¹⁷

As an aid to thinking about the nominal flexibility of exchange rates, Figure 2 shows examples of different types of arrangements as they existed in 2006.

¹⁷ Unlike many of the classification schemes in Box 1, Figure 1 does not have a separate category for baskets. A basket is a type of anchor rather than a type of nominal flexibility or a degree of convertibility. Baskets range from those with fixed, publicly announced components to those with variable, secret components. Nor does the scheme here have a separate category for episodes of floating that suffered high inflation, unlike Reinhart and Rogoff (2004, pp. 3-4). It is possible to have high inflation with any degree of nominal flexibility in terms of an anchor currency. Former Soviet republics that continued to use the Soviet/Russian ruble after the Soviet Union collapsed in 1991 had high inflation under a fixed rate because Russia’s central bank was creating high inflation.

Figure 2. Various exchange rate arrangements during 2006



Source: Daily data of markets rates from Bloomberg. There was in 2006 no country whose official arrangement was a crawling band. Iraq is an imperfect example.

6. MANAGED RATES DIFFER FROM UNMANAGED RATES

Adding convertibility to the picture rather than considering nominal flexibility alone gives a more accurate picture of how the foreign-exchange market works. The market is not the same in Panama as it is North Korea, even though a simple textbook account would classify both as countries as having “fixed” exchange rates. The portion of the U.S. dollar monetary base that is in Panama adjusts to demand through arbitrage, unimpeded by the government. In North Korea the purpose of monetary policy is to impede arbitrage through trade in foreign goods or foreign currency, because arbitrage would undermine the government’s attempt to direct the economy through central planning.

Exchange controls are not the only way of affecting how supply adjusts to demand in the foreign-exchange market. Another way is discretionary intervention, in which the monetary authority tries to make the monetary base or the exchange rate different from what they otherwise would be. The most common form of intervention is sterilized intervention. Under fully sterilized intervention, when a monetary authority buys or sells foreign currency, altering its net foreign assets, it undertakes an offsetting operation to sell or buy enough net domestic assets to leave the monetary base unchanged. (By definition, the monetary base equals the monetary authority’s net foreign assets plus its net domestic assets.)¹⁸

Managed exchange rates are those that involve exchange controls or discretionary intervention; unmanaged rates are those that do not. Although most economists who discuss international monetary matters acknowledge that a distinction between managed and unmanaged rates exists, few seem to consider it important, and textbooks often discuss it but rarely emphasize it. Economists who do emphasize the distinction, though, include such eminent figures as Milton Friedman and Robert Mundell.¹⁹

Along the top row of Figure 1, where full convertibility exists, each exchange rate arrangement has a managed and an unmanaged variant. In the lower rows, exchange controls by definition make the exchange rates managed. Following Friedman and Mundell, let us call a rigid, unmanaged rate a fix and a rigid, managed rate a peg. Sometimes people call a rigid exchange rate “pegged” if it has not lasted long, and “fixed” if it has. The distinction Friedman and Mundell emphasize rests on analytical differences: in particular cases, a fixed rate may last but a short time, while a pegged exchange rate may last for years. At the other extreme, let us call a fully floating, unmanaged rate a clean float and a fully floating, managed rate a free float. Between the extremes there seem to have been few cases historically in which monetary authorities have operated exchange rate arrangements in unmanaged fashion, even though it is possible. There have been few or no cases of monetary authorities that have adopted wide bands and treated the exchange rate as a clean float within the bands but as a fix at the edges. Accordingly, there are no special terms comparable to “fix” and “peg” that imply the distinction

¹⁸ Several studies have argued that for large economies without exchange controls, whatever durable effects sterilized intervention may have occur because it signals the intentions of the monetary authority, not because of its direct effect in changing the composition of balance sheets. The balance-sheet channel can still be important over short periods, in small economies that attract little currency speculation, or where regulations restrict financial arbitrage significantly.

¹⁹ Friedman (1998), Mundell (1997).

between the managed and unmanaged variants of exchange rates between rigid and fully floating.

The real supply of foreign exchange is the number of units offered times the purchasing power per unit. Exchange controls translate roughly into lower purchasing power per unit for currencies that have them. Unmanaged rates allow the real supply of foreign exchange to adjust to the real demand “automatically” through changes in the nominal monetary base (for a fixed rate), changes in the nominal exchange rate (for a clean float), or a combination of the two (for unmanaged rates between the extremes). Managed rates create situations in which the monetary authority is fighting the market by maintaining a real monetary base higher or lower than is compatible with demand in the foreign-exchange market at the going exchange rate.²⁰ A frequent case is that demand for the domestic monetary base is falling, but the central bank does not wish to reduce the monetary base because it fears higher interest rates, slower economic growth, and irate politicians. The central bank instead sells some of its foreign reserves to support the exchange rate. If the central bank persists, and demand for the domestic monetary base does not recover, the central bank eventually has no foreign reserves left and can no longer maintain the previous exchange rate. A currency crisis and devaluation result.

The distinction between managed and unmanaged exchange rates helps explain why arrangements often lumped together have had quite different outcomes. In the early 1990s the French franc was in effect pegged to the German mark through the Exchange Rate Mechanism of the European Monetary System. Repeated speculative attacks on the franc persuaded the French government to adopt wider margins of fluctuation in 1993. In 1999 France began to replace the franc with the euro, establishing a fixed exchange rate with Germany and other countries that use the euro. A simple textbook account, which would classify both episodes as having “fixed” exchange rates, cannot readily explain why speculative attacks on France’s currency occurred until 1993 but have been absent since 1999.

We can now connect the triangle in Figure 1 with the “impossible trinity” of monetary policy, which states that among the three goals of stability of the nominal exchange rate, independence in monetary policy, and convertibility, it is possible to achieve at most only two simultaneously, fully, and consistently.²¹ An unmanaged rigid rate (in the upper left-hand corner of the triangle) aims only at stability of the nominal exchange rate and full convertibility, eschewing independence in monetary policy. An unmanaged full float (in the upper right-hand corner) aims only at independence in monetary policy and full convertibility, eschewing stability of the nominal exchange rate. A repressed rate (in the bottom corner) aims only at stability of the nominal exchange rate, if it desires, and independence in monetary policy, eschewing convertibility.

²⁰ For an explanation that uses diagrams, see Schuler (1999, pp 87-90); Hanke (1998) makes some of the same points.

²¹ Although this insight is today associated with Robert Mundell (1963, pp. 484-5), it was understood by some economists of earlier generations, including Jacob Viner (1937, pp. 286-8) and George Poulett Scrope (1833, pp. 39-42). The case against managed exchange rates is not that they are impossible; it is that the inconsistent goals they embody create problems.

Managed exchange rates with full convertibility have an acute problem of consistency because they offer speculators many avenues to expose the underlying inconsistency of exchange rate policy. By limiting the degree of management or by occasionally abandoning it for awhile the monetary authority can avoid making itself an irresistible target for speculators. Exchange controls also reduce avenues for speculation and can for a time support an inconsistent policy. Over the long term, though, exchange controls tend to break down unless backed by intrusive and costly enforcement.

Thinking about exchange rates in terms of Figure 1 and of the distinction between managed and unmanaged rates helps explain how some East Asian countries were able to respond to their currency crisis of 1997-98 in different ways yet surmount the crisis successfully. Hong Kong, though already at the upper left-hand (rigid, fully convertible) corner, had policies that allowed for some degree of exchange rate management. It moved closer to an unmanaged rate by eliminating barriers to arbitrage at the official rate of 7.80 Hong Kong dollars per U.S. dollar. Singapore, which had a *de facto* crawling peg against the U.S. dollar and more or less full convertibility, allowed greater flexibility of the exchange rate, moving closer to the top right-hand (fully floating, fully convertible) corner. China, which had a *de facto* peg to the U.S. dollar and restricted convertibility, tightened exchange controls further, moving closer to the bottom (repressed) corner. As conditions permitted, China later loosened exchange controls. The underlying tension of remained, though. In July 2005, China allowed its exchange rate to become somewhat more flexible but it continues large-scale sterilization of inflows of capital.

7. BOTH WORDS AND DEEDS MERIT ATTENTION

An official exchange rate arrangement is what a government says it has. A *de facto* exchange rate is what it really has. The two may differ. Some governments have claimed to have floating rates but have actually maintained pegs. Others have maintained pegs but some transactions have occurred at a floating rate. In turn, the floating rate has in some cases been officially sanctioned, in others nominally illegal but tolerated, and in still others illegal and persecuted. Some governments have maintained official rates as accounting rates for certain foreign assets of their central banks, but no transactions have occurred at those rates.

Until the last several years, most analysis of exchange rates assumed that *de facto* arrangements matched official arrangements. Recent work on *de facto* classification schemes has performed a service by showing how widespread the divergence between words and deeds has been. However, *de facto* classifications that sort exchange rates only according to how the rate is determined at the margin can be as misleading as classifications that sort them only according to the main official rate. Unlike the cases in the simplest textbook models of price-setting, when multiple exchange rates exist either officially or *de facto*, the marginal price does not equal the average price. Exchange controls segment the market and prevent convergence of prices. An inframarginal price—the main official rate—can account for a significant proportion of transactions. People with access to the official rate face a different array of relative prices than people without access. We would expect them to act differently, with consequences for output.

Even where few transactions occur at the main official rate, it can influence the foreign exchange market, the policy of the monetary authority, and national politics because of what it represents

about a government's aspirations. Financial markets may react differently to a deviation from an officially announced band than from a longstanding but unannounced band. Officially stated intentions can also help distinguish cases in which exchange-rate stability is a goal of monetary policy from cases in which it is a byproduct of other policies. If two countries have floating exchange rates and similar inflation targets, their exchange rate may hold nearly steady even though neither country intervenes to maintain the rate. Classifying the exchange rate on the basis of observed market rates alone would result in terming the currency of the smaller country pegged to that of the bigger country, when in fact it is not.²²

As an example of why both official words and *de facto* deeds are important, consider the treatment Reinhart and Rogoff give to Belgium's exchange rate from October 1944 to April 1954.²³ Officially, the Belgian franc was pegged, first to the pound sterling and then to gold (or the dollar—it was ambiguous in the Bretton Woods system). On the basis of the behavior of the parallel rate, Reinhart and Rogoff classify the *de facto* exchange rate arrangement as a managed float. An argument supporting their procedure is that the parallel rate was the exchange rate at the margin. Some transactions occurred at the official rate, though, and for people who had access to the official market, the exchange rate was in fact pegged. Focusing only on the parallel market gives an incomplete picture of the rates at which transactions occurred.

8. MULTIPLE EXCHANGE RATES ARE HYBRIDS

Belgium was a case of two official exchange rates: a pegged “commercial” rate that applied to some transactions and a flexible “financial” rate that applied to others. Only three of the ten classification schemes in Box 1 make allowance for such multiple rates.²⁴ Levy-Yeyati and Sturzenegger's category for inconclusive exchange rate arrangements is a catch-all that can include arrangements where multiple rates makes a simple classification difficult. The IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions* describes multiple official rates in some detail, and for many countries is the only easily accessible source of information on the subject. The report also notes multiple exchange rates in one of the two summary tables that in recent issues appear in its opening pages. Reinhart and Rogoff go farthest, noting all cases where they have information of parallel market rates as well as of multiple official rates.

The most appropriate solution is to consider multiple rates explicitly to be hybrids. Doing so is messier than placing them in a single category, but it reflects messiness in actual exchange rate arrangements. In Figure 1, one could represent a dual rate with two dots connected by a line. If one is considering official and unofficial rates together, one rate would be the supposedly unitary official exchange rate, while the other rate would be the parallel market rate.

Comparing the importance of the official rate to that of other rates can be hard. Often, data on transaction volumes are not readily available, so one cannot determine the distribution of

²² Gensberg and Swoboda 2004, pp. 132-3.

²³ In the background material to Reinhart and Rogoff (2004).

²⁴ In this paper, a multiple exchange rate means any number of rates greater than one. Because of the high incidence of dual exchange rates historically, the IMF classifies exchange rates as unitary, dual, or multiple (three or more rates). In terms of their effect on exchange rate adjustment, the important division is between unitary rates and all others, not between two and three or more rates.

transactions between the official rate and other rates. The difference between the parallel rate and the official rate is a doubtful proxy for the volume in the parallel market. If the intensity of demand is high, the parallel rate can differ greatly from the official rate even though the volume of transactions in the parallel market is low. Many countries have consigned transactions for purchasing so-called luxury imports to the parallel market. If exchange control regulations treat kidney dialysis medicine as a luxury, the few people who need it to survive should be willing to pay dearly for foreign currency, and the parallel market rate may have a large spread over the official rate despite low volume. To repeat, in some cases Reinhart and Rogoff offer rough estimates of the volume of transactions occurring at the main official rate, other official rates, and the unofficial parallel market rate.

9. HISTORICAL AND INSTITUTIONAL CONTEXT MATTER

Recent research on *de facto* exchange rate arrangements has focused on analyzing statistics and has been light on historical and institutional context. Among the authors who have proposed classification schemes for *de facto* exchange rate, only Reinhart and Rogoff provide historical details. In a number of cases, however, insufficient attention to the official exchange rate leads them to make misleading classifications. One such case is their characterization of the Hong Kong dollar as having a *de facto* band with the pound sterling plus multiple rates from September 18, 1949 to August 22, 1962. In fact, Hong Kong's monetary authority, the Exchange Fund (which at the time was a currency board) maintained a unified official exchange rate of 16 Hong Kong dollars per pound sterling. Separately, there existed multiple rates with the U.S. dollar, transacted through commercial banks without the involvement of the Exchange Fund. The purpose of the dollar market was to allow a limited class of transactions that the British government considered conducive to Hong Kong's status as a trading port. Along with a similar market in Kuwait, Hong Kong's market in U.S. dollars was one of the few legal "holes" in the group of countries that used the pound sterling as their anchor currency and had a common set of exchange controls intended to prevent selling pressure on sterling. Hong Kong's controls existed to support the pound sterling, not to support the Hong Kong dollar. The Hong Kong government did not particularly want *any* controls (Hong Kong 1954, p. 16), but it had to accept them because Hong Kong was a British colony. Once one knows why Hong Kong had the controls, it is hard to characterize its exchange rate as a band with the pound sterling while characterizing Singapore, which at the time had a similar kind of currency board but no free market with the U.S. dollar, as having had a peg to the pound sterling.

Deeper research on historical and institutional context should involve primary sources. Some reliance on secondary sources is inevitable. For a number of countries, copies of primary sources are not readily accessible to most researchers before the last several years, when contemporary material has become available on the Internet. As historians are aware, though, secondary sources can distort or omit important facts. Primary sources such as central bank reports, national laws, and news stories (read judiciously) are most reliable.

10. FINAL WORDS

Relying only on official descriptions of exchange rate arrangements is often misleading. Recent work on *de facto* exchange rate arrangements has usefully emphasized the difference between

words and deeds. Unfortunately, it has also made communication about exchange rate arrangements harder by proliferating schemes of classification. Individual schemes often disagree with one another and many are incomplete or illogical. This paper has proposed a coherent scheme of classification that can accommodate the variety of historical experience with various exchange rate arrangements, official and *de facto*.

MATHEMATICAL APPENDIX

Here is some mathematics of points in the main text. Let us begin with a list of notation. Upper-case letters indicate quantities, in the economic sense of an amount of something demanded or supplied.

Table A1. Notation

a	Rate of crawl of floor (most appreciated rate) of exchange rate band
b	Distance of floor (most appreciated rate) from reference exchange rate
c	Rate of crawl of ceiling (most depreciate rate) of exchange rate band
d	Distance of ceiling (most depreciated rate) from reference exchange rate
D	Net domestic assets of the monetary authority, in units of local currency
d superscript	Demand
e	Nominal exchange rate, in units of local currency per unit of foreign currency
F	Net foreign assets of the monetary authority, in units of foreign currency
i superscript	Index, $i = 1, \dots, n$
M	Monetary base
Q	Quantity of foreign exchange traded at an exchange rate
r	Reference exchange rate for calculating floors and ceilings (often called the central rate, mid rate, or parity; it need not actually be in the center of the exchange rate band)
s superscript	Supply
t subscripts	Time indicators (period t, t-1)
w	Weighting coefficient; these coefficients sum to 1
x	Percentage change in the monetary base
y_1, y_2, y_3	Coefficients; may have any real value
Δ	Change
Σ	Sum

Exchange rate equation

A fairly general expression for exchange rate arrangements is:

$$(1 + a) (r_{t-1} - b) \leq e_t \leq (1 + c) (r_{t-1} + d), \text{ subject to } Q^s \leq Q^d$$

If necessary, we can add index superscripts i to distinguish among multiple exchange rates. Here, a is the rate of crawl of the floor of the exchange rate band; r is the reference exchange rate for calculating the width of the exchange rate band; b represents the distance from the reference rate to the floor of the band; c is the rate of crawl of the ceiling of the exchange rate band; and d represents the distance from the reference rate to the ceiling. The letter Q is a measure of whether exchange controls hamper foreign-exchange trading; if they do, there may be another official or unofficial exchange rate that needs to be considered as part of the country's exchange rate arrangement. The letters a , b , c , d , and r may be simple numbers or they may be the results of formulas that specify paths over time. For example, the floor of a band may be unchanging while the ceiling rises, widening the band. Under a commodity standard where the mint parity is the

reference rate, the floor and ceiling of the exchange rate band may vary according to market factors such as the cost of shipping gold from place to place.

Exchange rate flexibility

The table below represents different degrees of nominal exchange rate flexibility in terms of the general expression. For simplicity, it assumes that the exchange rate is unitary, with no exchange controls, so i superscripts are unnecessary. Where yesterday's exchange rate or reference rate does not matter for determining today's rate, the table omits t subscripts. The table also omits t subscripts for a , b , c , d and r because it assumes for simplicity that they are constants.

Table A2. Exchange rate flexibility

Degree of flexibility	Values of a , c (rate of crawl)	Value of $d - b$ (band width)	Resulting expression (in some cases, e_{t-1} becomes the reference rate r)
Rigid	0	0-2% ^a	$e_t = e_{t-1}$
Crawl	$\neq 0$	0-2% ^a	$e_t = e_{t-1} + a$
Band	0	$2\% < (d - b) \leq 30\%$	$r - b \leq e \leq r + d$
Crawling band	$\neq 0$ ^b	$2\% < (d - b) \leq 30\%$	$(1 + a)(r_{t-1} - b) \leq e_t \leq (1 + c)(r_{t-1} + d)$
Limited float ^c	0	$\sim 0 < (d - b) < \infty$	$e_{t-1} - b \leq e_t \leq e_{t-1} + c$ or $r \geq e > -\infty$ or $r \leq e < +\infty$
Full float	0	∞	$-\infty < e < +\infty$

Notes:

^a A bandwidth of 2 percent of the reference rate was the maximum allowed for a unitary exchange rate under the Bretton Woods system from 1946-1971. For simplicity, the last column of the table assumes that rigid and crawling rates have bands of zero width.

^b In some cases, one boundary of the band crawls while the other does not.

^c The exchange rate can fluctuate within a band whose width is limited but the rate has no predictable trend, or there can be a floor without a ceiling or a ceiling without a floor.

For *de facto* exchange rate arrangements that differ from official arrangements, it is desirable to specify the minimum period and maximum deviations that define an arrangement. These are empirical questions, and the frequency of data available may influence definitions. A researcher working with daily data may decide that it is appropriate to call *de facto* exchange rate "rigid" if it remains within a band of 2 percent of the average rate for the last 90 days at least 90 percent of the time, whereas a researcher working with monthly data may decide that the minimum period appropriate for defining a rate as rigid is 12 months but that deviations are permissible for up to two months out of 12, implying a minimum compliance rate of only 83 percent.

Convertibility

If full convertibility exists, $i = 1$, meaning the exchange rate is unitary, and no limits exist on the amount of foreign currency that can be traded at that rate, so $Q^{is} = Q^{id}$. If convertibility is not full, $i > 1$, meaning that in addition to the official exchange rate there is at least one other official or unofficial rate at which trading occurs. Also, for at least one exchange rate, $Q^{is} < Q^{id}$.

Managed exchange rates

A managed exchange rate is one in which the monetary authority tries to make the monetary base or the exchange rate different from what they would otherwise be. Indications of a managed rate are discretionary intervention in the foreign-exchange market or exchange controls.

Consider the supply of money in the sense of the monetary base, which is the aggregate under the direct control of the monetary authority. In the balance sheet of a monetary authority, the monetary base by definition equals net domestic assets plus net foreign assets (reserves). Net foreign reserves may be all valued at a single exchange rate, or different portions may be valued at different rates if multiple rates exist.

$$M^s \equiv D + \sum_{i=1}^n e^i w^i F$$

Let x be the change in the real demand for money, expressed in units of a foreign currency assumed to have constant purchasing power.

$$M_t^d = M_{t-1}^d + x, \text{ or } \Delta M^d = x$$

By assumption let x be nonzero. The table below shows how the supply of money adjusts to the change in demand under different types of exchange rate management. Partial adjustment is also possible, as is full adjustment by a mixture of change in the exchange rate and change in foreign reserves.

Table A3. Exchange rate management

Degree of management	Change in D (net domestic assets)	Change in e (exchange rate) ^a	Change in F (net foreign assets)	Resulting formula: $\Delta M_t^s =$	Equilibrium ($\Delta M^s = \Delta M^d$)?
Unmanaged, rigid	0	0	x	$e_{t-1}\Delta F$	Yes
Unmanaged full float	0	$-xe_{t-1} / M_{t-1}^d$	0	ΔeF_{t-1}	Yes
Intervention, no exchange controls	$y_1 D_{t-1}$ (= $-x$ if full sterilization)	$y_2 e_{t-1} / M_{t-1}^d$ (= 0 if full sterilization)	$y_3 F_{t-1}$ (= x if full sterilization)	$\Delta D + \Delta e\Delta F$ (= 0 if full sterilization)	No ^b
Repressed	0	0	0	0	No ^c

Notes:

^a The exchange rate is defined as units of local currency per unit of foreign currency, so if demand for money rises, under a flexible rate the exchange rate appreciates, meaning the number of units of local currency per unit of foreign currency falls.

^b If demand remains unchanged. The monetary authority can try offsetting steps to alter demand, at least temporarily, such as altering the required reserves of commercial banks.

^c The main official rate is unchanged, but the official or unofficial parallel rate changes by at least as much as in the case of a clean float if access to the parallel market is easy.

By assumption, the intervention case is not simply a combination of a fix and a clean float. Intervention can sterilize, offsetting part or all of the change in the money supply that would be transmitted through the change in the monetary authority's foreign assets; it can amplify the change; or it can change the money supply oppositely to the change in foreign assets.

If intervention prevents the monetary base from adjusting to demand, in the case of supply exceeding demand the effect is for the monetary authority to lose foreign reserves, to the extent the exchange rate is rigid, or for the exchange rate to depreciate, to the extent it is flexible. In the case of supply falling short of demand, the effect is for the monetary authority to gain foreign reserves, to the extent the exchange rate is rigid, or for the exchange rate to appreciate, to the extent it is flexible. If exchange controls exist, the extent of these changes depends on how leaky the controls are.

There are standard results from economic theory, not reproduced here, that an exchange rate out of equilibrium reduces the efficiency of the economy by hampering trades that would otherwise occur. For example, an undervalued rate results in lower real wages and lower imports than are efficient.

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