

money base. Likewise, if the monetary authority purchases more of its domestic currency and takes the receipts out of circulation, the intervention will have a contractionary effect on the domestic money base.

Sterilized intervention operations involve domestic asset transactions that restore the monetary base to its original size. For example, a nonsterilized sale of foreign currency on the open market would result in a reduction in the central bank's net foreign assets (NFA) and a contraction of the domestic monetary base (MB). This operation can be sterilized, or neutralized, by an offsetting purchase of domestic currency that increases the central bank's net domestic assets (NDA) and returns the monetary base to its original level.

In theory the process of sterilization is quite straightforward, but in practice it may be difficult for the monetary authority to fully offset the effects of a change in net foreign assets. In countries with less-developed financial markets the ability to sterilize may be constrained by the size and depth of the domestic bond market. Additionally, monetary authorities may not be able to sterilize intervention operations in fixed exchange rate systems with some degree of capital mobility (Obstfeld 1982). For example, sales of domestic-currency assets will attract a capital inflow, forcing the authorities to buy more foreign assets in order to maintain the fixed value of the currency, thereby offsetting any attempt to sterilize the original open-market asset sale.

Costs of Sterilization Sterilization may also come at a fiscal cost. Governments attempting to lower or maintain the value of their domestic currency in the face of market pressure for a domestic currency appreciation will generally be purchasing relatively low-yield foreign assets while selling relatively high-yield domestic assets. The fiscal burden of sterilization will depend on the interest differential between the domestic and foreign assets. Further, the international accumulation that results from these sorts of sterilization operations will expose the government to foreign exchange risk. If the domestic currency eventually appreciates relative to the foreign currency denominations in a country's reserves, the country will experience a capital loss. On the other

■ sterilization

Sterilization is the process by which monetary authorities ensure that foreign exchange interventions do not affect the domestic monetary base, which is one component of the overall money supply. Many governments try to influence the value of their currency on the foreign exchange market by selling or purchasing domestic currency in exchange for a foreign currency. If the monetary authority sells domestic currency that was not previously in circulation, the intervention will expand the domestic

hand, governments attempting to prevent a depreciation of their domestic currency will generally be selling foreign assets and purchasing domestic assets. The constraint in this case will be the size of the country's foreign reserves.

The Efficacy of Sterilized Intervention Operations In most monetary and asset-pricing models of exchange rate determination, nonsterilized intervention will affect the exchange rate in proportion to the change in the relative supplies of domestic and foreign money, just as any other form of monetary policy does. The effectiveness of sterilized intervention operations in standard models depends on two additional assumptions: that domestic and foreign bonds are outside assets (i.e., the public considers these bonds as net wealth) and that they are imperfect substitutes (meaning that the currency denomination of the bonds matters to investors). Sterilized intervention can also influence the exchange rate in models where the government is assumed to have more information about relevant economic fundamentals (such as future money and income differentials) than the market and can credibly convey that information using intervention operations.

Governments generally finance their spending by raising taxes or borrowing by issuing bonds. If they issue bonds, the public has more money to spend. Further, if the public ignores the fact that taxes will need to be raised in the future to pay off the bonds, these bonds can be considered “outside assets” and are additions to net wealth. On the other hand, if the public recognizes that they (or future generations) will have to pay higher taxes in the future and therefore save the extra money in order to pay the future tax, bonds are “inside assets” and cannot be considered net wealth. The extra saving by the public would exactly offset the extra spending by the government, so overall demand would remain unchanged. This view of the implications of bond financing is termed Ricardian equivalence. Sterilized intervention operations in such a world are simply swaps in the currency composition of inside assets, and these should have no effect on the foreign exchange market equilibrium.

Even if it is granted that government bonds are outside assets, sterilized intervention will have no effect on the exchange rate if domestic and foreign bonds are perfect substitutes. If investors are completely indifferent between holding domestic and foreign bonds, then changes in their relative supply should have no effect. If bonds are not perfect substitutes, however, even if they are close substitutes, then changes in bond supplies matter, so changes in their relative supply can influence the exchange rate through the portfolio-balance channel.

In portfolio-balance models of exchange rate determination, investors diversify their holdings among domestic and foreign bonds as a function of both expected returns and the variance in returns. By changing their relative supply, sterilized intervention operations alter the risk characteristics of foreign and domestic bonds in the market portfolio, and thus alter the equilibrium exchange rate. For example, a sterilized sale of domestic-currency-denominated bonds may increase their relative riskiness because investors will be more vulnerable to unexpected changes in the value of the domestic currency. Investors will require a higher expected return on domestic bonds to hold willingly the larger outstanding stock, leading to a depreciation of the domestic currency.

Finally, even for those who hold either to the Ricardian equivalence or to the assumption that foreign and domestic bonds are perfect substitutes, sterilized intervention can have an effect on exchange rates if it provides the market relevant information that was previously not known or not fully incorporated in the current exchange rate. The information channel for sterilized intervention is controversial. It relies on the existence of an asymmetry between what is known by the government and what is known by market participants. In order for sterilized intervention operations to influence exchange rates via the information channel, the government must both have inside information and have the incentive to reveal the information truthfully by way of their operations in the foreign exchange market. Indeed, it has been suggested that sterilized intervention may be used by governments to “buy credibil-

ity” for their future policy intentions (Mussa 1981). If market participants believe the signals provided by sterilized intervention, they will influence exchange rates by betting with the operation.

The information channel for sterilized intervention need not exclusively serve to convey future policy intentions. For instance, intervention helps to convey information by the monetary authorities to the market in circumstances when such information might not be made directly available for security or other reasons (Friedman 1953). Intervention signals may also alter the market’s expectations, especially when market participants are heterogeneous and there are signs of a bubble developing (Kenen 1987). As long as the information signaled through sterilized intervention policy is relevant and credible, it can potentially influence the exchange rate. If the information revealed involves the monetary authority’s own future policy intentions, however, then sterilized intervention should not be considered an additional independent policy tool. The sterilized intervention operation may alter the timing or magnitude of the impact of monetary or fiscal policy on the exchange rate, but its effectiveness is not independent of those policies.

Empirical Evidence Is there empirical evidence that sterilized intervention operations affect exchange rates? In 1982 the Group of Seven (G7) economic summit at Versailles commissioned a comprehensive study of intervention policy in order to answer the question. The G7 working group report, completed in 1983, draws no explicit conclusions but suggests that the effects of sterilized interventions on the exchange rate were small and transitory at most over the period 1973–81 (Jurgensen 1983). Subsequent studies of G3 intervention policy suggest that more recent operations may have been more effective (Dominguez 1990, 2003, 2006; Dominguez and Frankel 1993a, 1993b; Sarno and Taylor 2001).

An indirect test of the efficacy of sterilized intervention involves examining whether the assumptions underlying the portfolio-balance channel are satisfied in the data. In particular, one such test examines whether foreign and domestic bonds are imperfect substitutes in investors’ portfolios. If investors are

indifferent between holding domestic assets and foreign assets, then once we take into account both the current and expected exchange rate, there should be no return differential (or risk premium) between the two. This hypothesis is commonly referred to in the literature as the uncovered interest parity condition. Most empirical tests of uncovered interest parity find that foreign and domestic bonds are not perfect substitutes.

The failure of uncovered interest parity is a necessary but not a sufficient condition for sterilized intervention to affect the exchange rate through the portfolio-balance channel. There must be a stable relationship between government debt supplies and the return differential between domestic and foreign bonds, and empirical studies have had mixed success relating the two. Studies that include government debt and other outside assets, which usually dwarf foreign exchange intervention in magnitude, in the definition of government debt supplies reject the hypothesis that the two are related. Empirical studies using daily (and intraday) intervention data, which are able to focus exclusively on short-term changes in asset supplies through foreign exchange intervention, generally find evidence to support the hypothesis that sterilized intervention operations systematically influence return differentials (Dominguez 1990, 2003, 2006; Dominguez and Frankel 1993a, 1993b).

In order for the information channel to be operative, sterilized intervention operations must be observed by market participants. If only for this reason, it is puzzling that more governments do not disclose data on their intervention operations. Comparisons of actual intervention data with newswire reports of intervention suggest that G3 operations are generally reported in the financial media. Empirical tests that distinguish interventions that are reported (and therefore are capable of serving as signals) from those that remain secret generally find that it is mainly reported interventions that significantly influence exchange rates, providing indirect evidence for the signaling channel. The literature, however, has been less successful at finding a systematic link between reported interventions and future fundamentals (the information that is supposedly being conveyed by the

government), making it difficult to find direct evidence for signaling (Sarno and Taylor 2001).

Theory suggests that sterilized intervention operations can potentially provide governments an additional policy tool with which to attain internal and external balance. Practice suggests that governments in both fixed and flexible exchange rate systems have frequently resorted to sterilized intervention policy. Empirical studies of the efficacy of these operations suggest that intervention in developed countries has often been successful, though whether sterilized intervention can serve as a fully independent policy tool remains controversial. The efficacy of sterilized intervention policies in developing countries has been less widely studied, in large part because governments have been reluctant to provide data on their operations. Developing countries are also not always able to fully sterilize their operations due to their illiquid domestic bond markets and the potentially high fiscal costs of foreign reserve accumulation.

See also asymmetric information; balance of payments; equilibrium exchange rate; exchange rate regimes; exchange rate volatility; foreign exchange intervention; interest parity conditions; international reserves; money supply; purchasing power parity; real exchange rate; twin deficits

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