Competitive devaluations: toward a welfare-based approach*

Giancarlo Corsetti
University of Bologna and Yale University

Paolo Pesenti
Federal Reserve Bank of New York and NBER

Nouriel Roubini
New York University, CEPR and NBER

Cédric Tille
Federal Reserve Bank of New York

First draft: October 1998
Revised: May 1999

*We thank three anonymous referees, Mark Gertler, Linda Goldberg, Peter Kenen, Robert Kollman, Michael Kumhoff, Roberto Rigobon, Andres Velasco, Philippe Weil, and seminar participants at NYU, Princeton, FRBNY, INSEAD, IGIER-Bocconi, ECARE, and the conferences on "Globalization, Capital Market Crises and Economic Reform", Duke University, December 1998, and "Analytic Models of Currency Crises", NBER, February 1999, for helpful comments. The views expressed here are those of the authors, and do not necessarily reflect those of the Federal Reserve Bank of New York, or any other institution with which the authors are affiliated. Correspondence: corsetti@econ.yale.edu, paolo.pesenti@ny.frb.org, nroubini@stern.nyu.edu, and cedric.tille@ny.frb.org.

Abstract

This paper revisits the international transmission of exchange rate shocks in a multi-country economy, providing a choice-theoretic framework for the policy analysis and empirical assessment of competitive devaluations. We develop a general equilibrium model with monopolistic competition and nominal rigidities and study the impact of a devaluation by one country on its trading partners. As opposed to the traditional view, the contraction in output and the current account deficit experienced by the neighbor countries need not imply that a devaluation has an adverse *beggar-thy-neighbor* effect. On the contrary, if the law of one price holds (full exchange rate pass-through) the neighbor countries can benefit from an improvement in their terms of trade. Furthermore, a retaliatory devaluation need not be the optimal strategy for the neighbor countries, as the induced terms of trade deterioration can be large enough to offset the gains from defending their export market share. When the law of one price does not hold (zero exchange rate pass-through) a country's devaluation has an unambiguous negative welfare impact on the economies of its trading partners based on the fall of their export revenues and profits and the increase in disutility from higher labor effort for any level of consumption.

J.E.L. classification F31, F32, F41, F42.

Keywords: competitive devaluations; exchange rate shocks; contagion; global trade links; law of one price.

"The concern over competitive devaluations reflected in the Fund's charter, and the system-wide implications of changes in exchange rates, still motivate Fund policy recommendations. A major Fund concern in the Asian crisis has been the fear that Asian currencies would become so undervalued and current account surpluses so large as to damage the economies of other countries, developing countries included. This is one reason the Fund has stressed the need first to stabilize and then to strengthen exchange rates in the Asian countries now in crisis — and for this purpose, not to cut interest rates until the currency stabilizes and begins to appreciate." Stanley Fischer, "The IMF and the Asian Crisis", Los Angeles, March 20, 1998.

1 Introduction

The use of exchange rate policy to gain competitive advantage over a country's trading partners has long been recognized as a major threat to the stability of the international monetary system. Since Bretton Woods, concerns over 'competitive devaluations' have motivated the design of institutions and rules to prevent countries from adopting *beggar-thy-neighbor* exchange rate policies and starting devaluation spirals. Such concerns — as the epigraph highlights — have remained strong during the most recent events in Asia, playing a key role in shaping crisis management strategies and policy prescriptions in the region.

Despite the objective relevance of the notion of competitive devaluation in policy analysis and design, the analytical literature has devoted relatively little attention to the logical structure of the argument. Specifically, the literature typically qualifies a devaluation as *beggar-thy-neighbor* only insofar as a weaker currency spurs output growth and employment domestically at the expense of output growth and employment abroad.[1] But clearly these are not the only elements that are relevant in assessing the welfare impact

[1] The standard reference is Ragnar Nurkse's analysis of the devaluations that took place in the interwar period: "in contemporary discussions much stress was laid on the competitive aspects of currency devaluation. In many quarters devaluation was regarded primarily as a means of improving a country's foreign trade balance and hence its volume of domestic employment — an effective means but one that operated necessarily at the expense of other countries and invited retaliation" (Nurkse (1944), p.129).

of exchange rate policies. Unfortunately, the analytics of a competitive devaluation[2] is generally derived from some version of the classic Mundell-Fleming-Dornbusch model, which lacks explicit micro-foundations and does not provide a consistent welfare criterion for policy assessment. In fact, 'welfare' analysis in the traditional scheme is typically based on ad-hoc objective functions representing some arbitrarily weighted averages of current account, price and employment effects.

Drawing on recent developments in open-economy macroeconomics,[3] this paper studies the logical foundations of competitive devaluations using a theoretical apparatus that is apt at carrying out welfare analysis. Analogous to the traditional models of international transmission of exchange rate shocks, our construction allows for short-run nominal rigidities and highlights the role of losses in cost-competitiveness experienced by trading partners when a country devalues. In contrast to the traditional analyses, however, we assess *beggar-thy-neighbor* effects (or the absence thereof) within a choice-theoretic framework.

The need for thoroughly revisiting the logic of competitive devaluations is particularly evident in light of the recent proliferation of studies on currency and financial 'contagion'. Based on the experience of Western Europe in 1992-93, Latin America in 1994-95, Southeast Asia in 1997-98 and Russia in 1998, system-wide surges in interest rate and exchange rate volatility have represented a recurring pattern in the crises of the 1990s.[4] Some theoretical contributions have suggested that a currency crisis in one country may worsen market participants' perception of the economic outlook in countries with similar characteristics, triggering margin calls and information cascades.[5] Other contributions have argued that, when multiple instantaneous equilibria can occur as rational phenomena, what drives contagion are parallel shifts in financial markets' expectations affecting more than one currency

[2] For a comprehensive survey see Kenen (1985).

[3] See among others Obstfeld and Rogoff (1995, 1996 ch.10, 1998), Corsetti and Pesenti (1997), Tille (1999), Devereux and Engel (1998).

[4] Among recent studies focusing on the large-scale speculative episodes in the 1990s, see *e.g.* Eichengreen and Wyplosz (1993) and Buiter, Corsetti and Pesenti (1998a, b) on the European Monetary System crisis of 1992-93, Sachs, Tornell and Velasco (1996) on the Mexican peso crisis of 1994, and IMF (1997, 1998a,b) and Corsetti, Pesenti and Roubini (1999a,b) on the Asian crisis since 1997. For recent analyses of cross-border financial contagion see *e.g.* Baig and Goldfajn (1998) and Forbes and Rigobon (1998).

[5] See *e.g.* Calvo and Mendoza (1997), Calvo (1998), Chari and Kehoe (1997) and Drazen (1998).

simultaneously.[6]

Currency instability also spreads, however, via structural links across countries: a devaluation by one country affects the state of economic fundamentals — and may induce exchange rate tensions — elsewhere in the world economy. Recent econometric research highlights the role of trade links — together with financial and macroeconomic variables — as determinants of the international transmission of exchange rate crises.[7] Because of trade links, a country-specific currency crisis increases the incentive to devalue for other countries, and with it the likelihood and scope of speculative attacks in foreign exchange markets. In other words, 'competitive' devaluations have recently been re-interpreted as 'contagious' devaluations.[8]

Our methodology takes the initial devaluation in one country as an exogenous shock (without modeling what causes such devaluation in the first place), and focuses on the welfare repercussions of this shock on the economies of the trading partners and competitors. If the latter are better off by devaluing their exchange rates in turn, international domino effects can be understood as rational phenomena based on the assessment of social welfare costs and benefits. Moreover, to the extent that shifts in market sentiment reflect expectations of competitive devaluations, a systematic study of the mechanism of exchange rate transmission can contribute to our understanding of contagious speculative attacks driven by a deterioration of confidence.[9]

---

[6] See *e.g.* Masson (1998).

[7] See *e.g.* Eichengreen, Rose and Wyplosz (1996) and Glick and Rose (1998). Kaminsky and Reinhart (1998) compare alternative approaches to contagion. Caramazza, Ricci and Salgado (1999) investigate the past three major crisis episodes in emerging economies (Mexico, Asia and Russia) using a pooled probit model to estimate the impact of several indicators of vulnerability on the probability of suffering a crisis. They find a significant effect of trade linkages, especially in the Asian episode, in determining contagion across countries.

[8] This interpretation seems to provide the theoretical underpinnings of the recent IMF prescriptions in Asia. Quoting once again from the speech by Stanley Fischer mentioned in the epigraph, "from the viewpoint of the international system, the devaluations in Asia will lead to large current account surpluses in those countries, damaging the competitive positions of other countries and requiring them to run current account deficits. Although not by the intention of the authorities in the crisis countries, these are excessive competitive devaluations, not good for the system, not good for other countries, indeed *a way of spreading the crisis* — precisely the type of devaluation the IMF has the obligation to seek to prevent" (our italics). On the issue of competitive devaluations in Asia see also Liu, Noland, Robinson and Wang (1998) and Fernald, Edison and Loungani (1998).

[9] See *e.g.* IMF (1998b, p.48): "the floating of the baht engendered among market

The paper is organized as follows. Section 2 presents the structure of the 3-country *Center-Periphery* model underlying our analysis. Section 3 studies the positive aspects of the mechanism of international transmission of exchange rate shocks. Sections 4-5 focus on the welfare repercussions of devaluation shocks, both between Center and Periphery (Section 4) and within the Periphery (Section 5). Section 6 revisits the mechanism of policy transmission in the presence of deviations from the law of one price. Section 7 concludes.

2 The setup

2.1 A three-country economy

Our theoretical framework consists of a general equilibrium *3-country* model with nominal rigidities and monopolistic competition.[10] The multi-country setup allows us to study different trade channels of transmission of exchange rate shocks, namely bilateral trade and competition in third markets. As in the traditional literature the introduction of short-run nominal rigidities is motivated in terms of empirical plausibility and realism. Finally, by characterizing economy-wide distortions in terms of monopoly power it is possible to formulate a logically coherent case for monetary and exchange rate intervention, with a rigorous justification for the assumption that output is demand-determined when prices are fixed.

There are three *types* of goods in the word economy, and each country specializes in the production of one type of goods only. Types (and countries) are denoted A, B, and C. The central characteristic of our model is that two countries, A and B, produce types of goods that are fairly close substitutes for

participants the perception of a need for competitive devaluations among currencies in the region, and caused investors to take a closer look at the similar financial sector problems, albeit to different degrees, in the region."

[10] We assume that the reader is familiar with the benchmark two-country 'redux' model studied in Obstfeld and Rogoff (1995, 1996). Our construction departs from the 'redux' model in two important respects. First, it extends the analytic framework to a multi-country setup. Second, and most important, we do not restrict the elasticities of substitution between foreign and domestic goods to be equal to the degree of monopolistic competition. The latter refinement, as adopted by Corsetti and Pesenti (1997), Tille (1999) and Obstfeld and Rogoff (1998), allows for a comprehensive treatment of both demand and terms of trade externalities in the welfare analysis of an open economy.

each other, but poor substitutes for the goods produced in the other country, C. To pin down the intuition, one may think that country C produces computers, while countries A and B produce textiles, say, shirts and sweaters respectively. Hereinafter country C will be referred to as the *Center*, while countries A and B as a whole will be referred to as the *Periphery*.

For each type of good there exists a continuum of *brands*, each of whose is an imperfect substitute to all other available brands. All brands are traded worldwide. Following Obstfeld and Rogoff (1995, 1996), the world is populated by households (consumer-producer units) and each household is assumed to consume all brands of all types but to be the sole producer of a specific brand. Technology is such that one unit of household labor produces one unit of output.

Households (and brands) are defined over a continuum of unit mass. Defining as γ_P the Periphery share of world population and as γ_A country A's share of Periphery population, with $\gamma_A, \gamma_P \in (0,1)$, households on the interval $[0, \gamma_A\gamma_P)$ live in country A, households on the interval $[\gamma_A\gamma_P, \gamma_P)$ live in country B, and households on the interval $[\gamma_P, 1]$ live in country C.[11]

2.2 Utility and budget constraint

The objective of household x, living in country j at time t, is defined as:[12]

$$U_t^j(x) = E_t \sum_{s=0}^{\infty} \beta^s \left\{ \ln C_{t+s}^j(x) - \frac{\kappa}{2}\left(Y_{t+s}^j(x)\right)^2 + \chi \ln\left(\frac{M_{t+s}^j(x)}{P_{t+s}^j}\right)\right\} \quad (1)$$

Inside the curly brackets, the first term is the instantaneous utility from consumption, where $C^j(x)$ is a consumption basket to be defined below; the second term is the disutility from labor effort, where $Y^j(x)$ is the output of the brand produced by household x; the third term is utility from liquidity services, where $M^j(x)$ denotes household x's holdings of country j's currency, and P^j is the price of one unit of the consumption basket in terms of country j's currency. The discount rate is denoted β, and the other Greek letters denote positive constants.

[11] In other words, the population sizes of country A, B and C are equal to $\gamma_A\gamma_P$, $(1-\gamma_A)\gamma_P$ and $1-\gamma_P$ respectively.

[12] To facilitate the comparison with the literature, where possible we adopt the same notation and parameterization of the Obstfeld and Rogoff (1996) textbook.

Household x in country j holds domestic currency, $M^j(x)$, and a nominal bond denominated in the Center's currency, $B^j(x)$. Only country j's residents are assumed to hold country j's money, while the bond is in zero-net supply worldwide. The household budget constraint is therefore:

$$\begin{aligned} & \frac{E_t^j B_{t+1}^j(x)}{P_t^j} + \frac{M_t^j(x)}{P_t^j} + C_t^j(x) \\ = \; & (1+i_t)\frac{E_t^j B_t^j(x)}{P_t^j} + \frac{M_{t-1}^j(x)}{P_t^j} + \frac{SR_t^j(x)}{P_t^j} - \frac{T_t^j(x)}{P_t^j} \end{aligned} \tag{2}$$

where E^j is the nominal exchange rate, defined as country j's currency per unit of Center currency (so that $E^C = 1$); i is the nominal yield on the bond in terms of the Center's currency;[13] $SR^j(x)$ is agent x's sale revenue in nominal terms, detailed below; and $T^j(x)$ is a lump sum tax denominated in country j's currency.

2.3 Consumption baskets, elasticities of substitution and price indexes

We now define the household consumption baskets. In what follows, superscripts denote the nationality of the consumer, while subscripts index the country in which a particular good is produced — for simplicity we omit the time subscript. For instance, $C_A^C(z,x)$ denotes consumption by household x located in country C of the brand produced by household z located in country A. The consumption sub-indexes across the brands produced in each country, $C_k^j(x)$ for $j,k = A,B,C$, are summarized in Table 1.[14] As mentioned above, brands are imperfect substitutes for each other. The elasticity of substitution across brands in any country is equal to θ, and we assume that $\theta > 1$.[15]

[13] The currency of denomination of the international bond does not affect our results. By no arbitrage in the bond market (uncovered interest parity), the local-currency gross return on the bond is equal to $\left(1+i_{t+1}^j\right) = (1+i_{t+1})\left(E_{t+1}^j/E_t^j\right)$, $j = A,B,C$.

[14] For instance, $C_A^C(x)$ is the basket of all goods imported from country A and consumed by household x in country C.

[15] As in Obstfeld and Rogoff (1995, 1996) the parameter θ turns out to be the price elasticity of demand faced by each monopolist household. The assumption $\theta > 1$ guarantees that there exists an interior equilibrium with a positive level of output.

Table 1: Consumption and price indexes

Consumption indexes

$$C_A^j(x) = \left[(\gamma_A\gamma_P)^{-\frac{1}{\theta}} \int_0^{\gamma_A\gamma_P} \left(C_A^j(z,x)\right)^{\frac{\theta-1}{\theta}} dz\right]^{\frac{\theta}{\theta-1}}$$
$$C_B^j(x) = \left[((1-\gamma_A)\gamma_P)^{-\frac{1}{\theta}} \int_{\gamma_A\gamma_P}^{\gamma_P} \left(C_B^j(z,x)\right)^{\frac{\theta-1}{\theta}} dz\right]^{\frac{\theta}{\theta-1}}$$
$$C_C^j(x) = \left[(1-\gamma_P)^{-\frac{1}{\theta}} \int_{\gamma_P}^{1} \left(C_C^j(z,x)\right)^{\frac{\theta-1}{\theta}} dz\right]^{\frac{\theta}{\theta-1}}$$

where $C_k^j(z,x)$ is consumption by household x in country j of the good produced by household z in country k

Utility-based price indexes

$$P_A^j = \left[\frac{1}{\gamma_A\gamma_P} \int_0^{\gamma_A\gamma_P} \left(P_A^j(z)\right)^{1-\theta} dz\right]^{\frac{1}{1-\theta}}$$
$$P_B^j = \left[\frac{1}{(1-\gamma_A)\gamma_P} \int_{\gamma_A\gamma_P}^{\gamma_P} \left(P_B^j(z)\right)^{1-\theta} dz\right]^{\frac{1}{1-\theta}}$$
$$P_C^j = \left[\frac{1}{1-\gamma_P} \int_{\gamma_P}^{1} \left(P_C^j(z)\right)^{1-\theta} dz\right]^{\frac{1}{1-\theta}}$$
$$P_P^j = \left[\gamma_A \left(P_A^j\right)^{1-\psi} + (1-\gamma_A)\left(P_B^j\right)^{1-\psi}\right]^{\frac{1}{1-\psi}}$$
$$P^j = \left[\gamma_P \left(P_P^j\right)^{1-\rho} + (1-\gamma_P)\left(P_C^j\right)^{1-\rho}\right]^{\frac{1}{1-\rho}}$$

where $P_k^j(z)$ is the price in country j of the good produced by household z in country k

Using the definitions above, the consumption basket of household x living in country j is defined as the following CES index:

$$C^j(x) = \left[\gamma_P^{\frac{1}{\rho}} \left(C_P^j(x)\right)^{\frac{\rho-1}{\rho}} + (1-\gamma_P)^{\frac{1}{\rho}} \left(C_C^j(x)\right)^{\frac{\rho-1}{\rho}}\right]^{\frac{\rho}{\rho-1}}$$

where ρ is the elasticity of substitution between the types of goods produced in the Center and the Periphery (computers and textiles). In turn, the basket of goods produced in the Periphery is defined as:

$$C_P^j(x) = \left[\gamma_A^{\frac{1}{\psi}} \left(C_A^j(x)\right)^{\frac{\psi-1}{\psi}} + (1-\gamma_A)^{\frac{1}{\psi}} \left(C_B^j(x)\right)^{\frac{\psi-1}{\psi}}\right]^{\frac{\psi}{\psi-1}}$$

where ψ is the elasticity of substitution between the types of goods produced in the Periphery countries (shirts and sweaters).[16]

The key assumption of our model is that *the elasticity of substitution between the types of goods produced in the Periphery countries (shirts vs. sweaters) is higher than that between the types produced in the Periphery and the Center (textile vs. computers), that is* $\rho \leq \psi$. Moreover, consistent with the idea that each country specializes in the production of a single type of good, the elasticity of substitution among goods produced in one country should not be lower than the elasticity of substitution across goods produced in different countries. We therefore posit $\rho \leq \psi \leq \theta$.

Finally, in Table 1 we also define the utility-based price indexes corresponding to the consumption indexes above. As a reminder, the utility-based price index is defined as the minimum expenditure required to buy one unit of a consumption basket.

2.4 Optimality

Households maximize (1) subject to (2). The optimal consumption allocation is summarized in Table 2. Due to imperfect substitutability across brands, households operate in a regime of monopolistic competition and face negatively sloped demand curves for their products. The demand for the brand produced by household x is obtained by integrating the demands presented in Table 2 across all households worldwide. The resulting expressions for the

[16] Note that the weights of the country indexes in preferences are assumed to be related to country sizes. This normalization simplifies the algebra without affecting the results.

Table 2: Consumption allocation

$$
\begin{aligned}
C_A^j(z,x) &= \left[\frac{P_A^j(z)}{P_A^j}\right]^{-\theta}\left[\frac{P_A^j}{P_P^j}\right]^{-\psi}\left[\frac{P_P^j}{P^j}\right]^{-\rho} C^j(x) \\
C_B^j(z,x) &= \left[\frac{P_B^j(z)}{P_B^j}\right]^{-\theta}\left[\frac{P_B^j}{P_P^j}\right]^{-\psi}\left[\frac{P_P^j}{P^j}\right]^{-\rho} C^j(x) \\
C_C^j(z,x) &= \left[\frac{P_C^j(z)}{P_C^j}\right]^{-\theta}\left[\frac{P_C^j}{P^j}\right]^{-\rho} C^j(x)
\end{aligned}
$$

output of household x in country j, $Y^j(x)$, and its sales revenue, $SR^j(x)$, are given in Table 3. We only present the results for country A's residents, with the understanding that similar expressions characterize demand and sales revenue in the other countries.

The other household equilibrium conditions are summarized by the following Euler and money demand equations, obtained by maximizing the objective function with respect to holdings of bonds and money:

$$\frac{C_{t+1}^j(x)}{C_t^j(x)} = \beta(1+i_{t+1})\frac{P_t^j/E_t^j}{P_{t+1}^j/E_{t+1}^j} \tag{3}$$

$$\frac{M_t^j(x)}{P_t^j} = \chi C_t^j(x)\frac{(1+i_{t+1})E_{t+1}^j}{(1+i_{t+1})E_{t+1}^j - E_t^j} \tag{4}$$

Equation (3) describes the optimal intertemporal allocation of consumption. Equation (4) implies that optimal real balances are positively related to consumption and negatively to the local-currency nominal interest rate. Finally, the optimization of (1) with respect to output yields the equilibrium markups

Table 3: Demand and sales revenue

Demand

$$
\begin{aligned}
Y^A(x) = &\left[\frac{P_A^A(x)}{P_A^A}\right]^{-\theta}\left[\frac{P_A^A}{P_P^A}\right]^{-\psi}\left[\frac{P_P^A}{P^A}\right]^{-\rho}\gamma_A\gamma_P C^A \\
&+\left[\frac{P_A^B(x)}{P_A^B}\right]^{-\theta}\left[\frac{P_A^B}{P_P^B}\right]^{-\psi}\left[\frac{P_P^B}{P^B}\right]^{-\rho}(1-\gamma_A)\gamma_P C^B \\
&+\left[\frac{P_A^C(x)}{P_A^C}\right]^{-\theta}\left[\frac{P_A^C}{P_P^C}\right]^{-\psi}\left[\frac{P_P^C}{P^C}\right]^{-\rho}(1-\gamma_P)C^C
\end{aligned}
$$

$$
\begin{aligned}
C^A &= \frac{1}{\gamma_A\gamma_P}\int_0^{\gamma_A\gamma_P} C^A(q)\,dq \\
C^B &= \frac{1}{(1-\gamma_A)\gamma_P}\int_{\gamma_A\gamma_P}^{\gamma_P} C^B(q)\,dq \\
C^C &= \frac{1}{1-\gamma_P}\int_{\gamma_P}^{1} C^C(q)\,dq
\end{aligned}
$$

Sales revenue

$$
\begin{aligned}
SR^A(x) = &P_A^A(x)\left[\frac{P_A^A(x)}{P_A^A}\right]^{-\theta}\left[\frac{P_A^A}{P_P^A}\right]^{-\psi}\left[\frac{P_P^A}{P^A}\right]^{-\rho}\gamma_A\gamma_P C^A \\
&+\frac{E^A}{E^B}P_A^B(x)\left[\frac{P_A^B(x)}{P_A^B}\right]^{-\theta}\left[\frac{P_A^B}{P_P^B}\right]^{-\psi}\left[\frac{P_P^B}{P^B}\right]^{-\rho}(1-\gamma_A)\gamma_P C^B \\
&+E^A P_A^C(x)\left[\frac{P_A^C(x)}{P_A^C}\right]^{-\theta}\left[\frac{P_A^C}{P_P^C}\right]^{-\psi}\left[\frac{P_P^C}{P^C}\right]^{-\rho}(1-\gamma_P)C^C
\end{aligned}
$$

with flexible prices:[17]

$$\frac{P_{j,t}^{j}(x)}{P_{t}^{j}} = \frac{\theta\kappa}{\theta-1} C_{t}^{j}(x) Y_{t}^{j}(x) \tag{5}$$

As we focus on equilibria in which households behave symmetrically within each country, we can drop the x indexes and interpret the household equations as per capita equations. Under the assumption that revenues from seigniorage are rebated to the public through a lump-sum transfer, the nominal budget constraint of the public sector can thus be written as:

$$M_{t}^{j} - M_{t-1}^{j} + P_{t}^{j} T_{t}^{j} = 0.$$

We can also rewrite the nominal budget constraint of a representative household in country j as the current account equation in per capita terms:

$$E_{t}^{j}\left(B_{t+1}^{j} - B_{t}^{j}\right) = SR_{t}^{j} + i_{t} E_{t}^{j} B_{t}^{j} - P_{t}^{j} C_{t}^{j}$$

where the left hand side is accumulation of net claims on the rest of the world and the right hand side is domestic output minus absorption. Finally, since the nominal bond is in zero supply worldwide, we have:

$$\gamma_{A}\gamma_{P} B_{t}^{A} + (1-\gamma_{A})\gamma_{P} B_{t}^{B} + (1-\gamma_{P}) B_{t}^{C} = \gamma_{P} B_{t}^{P} + (1-\gamma_{P}) B_{t}^{C} = 0$$

2.5 Short vs. long run

In our exercise the economy starts off at time $t = 0$ in a symmetric equilibrium *á-la*-Obstfeld-Rogoff (1995, 1996), where the net-asset positions across countries are all equal to zero,[18] and agents do not expect any change in monetary policy.[19] The prices of the individual brands are thus determined

[17] Note that the markups are independent of both elasticities of substitution across countries (*i.e.*, ρ and ψ); only the intra-country elasticity of substitution θ enters equation (5). In fact, the disutility of effort in terms of consumption depends on θ, whereas ρ and ψ determine the rate at which exports, to the Center and the other Periphery country respectively, are transformed into consumption.

[18] We leave to future contributions the formal analysis of competitive devaluations under scenarios in which country B is a net debtor in the initial equilibrium and its debt is denominated in foreign currency. Intuitively, such circumstances would increase the welfare costs of a devaluation since a fall in the price of foreign currency raises the real burden of country B's external debt.

[19] It can be checked that in the initial equilibrium all households produce and consume an amount $C_0 = \sqrt{(\theta-1)/(\theta\kappa)}$, irrespective of their country of residence.

according to the equilibrium (flexible-price) conditions of the model; it is straightforward to show that all prices, when expressed in terms of the same currency, are identical across countries at time $t = 0$. Starting from such equilibrium, we then study the positive and welfare impact on the world allocation of a permanent, unanticipated monetary shock in country A occurring at time $t = 1$ (so that $M_1^A - M_0^A > 0$, $M_{\tau+1}^A - M_\tau^A = 0$ for $\tau > 0$).

At the time of the shock (hereinafter referred to as *short run*), the economies are characterized by *nominal rigidities*: prices are predetermined and producers are willing to accommodate any increase in demand at given prices,[20] so that condition (5) does not necessarily hold. The adjustment is assumed to take one period only. In the *long run* ($t \geq 2$), prices fully adjust to their new equilibrium levels determined according to (5).

Sections 3-5 consider the case in which prices are predetermined in terms of the *sellers' currency*, while section 6 discusses the case in which prices are predetermined in the *buyers' currency*. In the first case, domestic firms do not modify the nominal prices of their products in the national markets ($P_A^A(z)$, $P_B^B(z)$ and $P_C^C(z)$ are fixed at $t = 1$ at the same level prevailing at time $t = 0$) and *the law of one price holds*: international *arbitrageurs* buy cheap and sell dear across markets, until prices expressed in terms of a common currency are equalized worldwide (so that, for instance, $P_C^A(z) = E^A P_C^C(z)$). In the second case, markets are segmented and *the law of one price does not necessarily hold*: $P_k^j(z)$ are constant in the short run for all $j, k = A, B, C$. In the long run, however, prices fully adjust to their new equilibrium levels, endogenously conforming to the law of one price.

2.6 Methodology

The algebraic complexity of our setup makes it impossible to analyze the impact of discrete shocks without resorting to numerical simulations. In what follows, we choose instead to focus on 'small' monetary shocks originating in country A and reformulate the model in terms of log-deviations from the initial equilibrium, as in Obstfeld and Rogoff (1995, 1996).

[20] A word of caution is warranted here. Consistently with the current macro literature, our analysis takes price rigidities as a *datum*, *i.e.* does not attempt to develop microeconomic foundations for either price stickiness or pricing to market. This means that, by construction, the analysis excludes a price response by firms to policy and fundamental shocks. Also, with imperfectly competitive goods markets and nominal rigidities output is demand determined only insofar as prices remain above marginal costs.

It is worth emphasizing what can be achieved through our approach, and what cannot. Our modelling strategy allows us to derive a set of baseline results, based on a non-arbitrary welfare metric, regarding whether and how exchange rate shocks in one country hurt the economies of its trading partners, and study under what conditions the latter have a welfare incentive to respond to a devaluation by devaluing in turn. Our methodology, however, does not encompass the strategic implications of exchange rate shocks in terms of devaluation 'spirals', optimal retaliations and non-cooperative equilibria. Our results are therefore to be considered as building blocks towards a full-fledged model of competitive devaluations, cast within a game-theoretical framework, and addressing strategic issues in exchange rate policy.[21]

As a general rule, in what follows lowercase letters denote log-linear approximations:

$$x_t \approx \frac{X_t - X_0}{X_0}$$

where X_0 is the level of a variable in the initial equilibrium and X_t the new (post-shock) level of the variable. The only exception to this rule concerns the stock of international debt.[22] Consistently with our notational conventions, throughout the paper we define Periphery-wide and worldwide variables as follows:

$$\begin{aligned} x_t^P &\equiv \gamma_A x_t^A + (1-\gamma_A)\, x_t^B \\ x_t^W &\equiv \gamma_P x_t^P + (1-\gamma_P)\, x_t^C \end{aligned}$$

Since the short run only lasts one period ($t = 1$) and all variables are constant at their steady-state level from time $t = 2$ onward, we can considerably simplify the notation by dropping time subscripts and denoting long-run variables with upperbars, to distinguish them from short-run variables. For example, c^B and $\bar{c}^B$ are (the percentage deviations from the initial steady state of) country B per-capita consumption in the short and the long run respectively.

[21] A first attempt at characterizing strategic interactions within a similarly microfounded 2-country model with monopolistic competition and nominal rigidities can be found in Corsetti and Pesenti (1997).

[22] Since $B_0^j = 0$ by construction, in our log-linearization we relate changes in net asset positions to the initial national consumption level, to write: $b_t^j \approx \left[\left(B_t^j - B_0^j\right) E_t^j\right] / \left(P_0^j C_0\right) = B_t^j / \left(P_0^C C_0\right)$.

3 International effects of country A's devaluation

As discussed above, in our analysis *we consider an exogenous permanent unanticipated monetary expansion in country* A, that is $m^A = \bar{m}^A > 0$. Since a monetary expansion in country A is always associated with a depreciation of its currency against the Center ($\bar{e}^A > 0$),[23] we will interchangeably refer to country A's shock as a monetary innovation or an unanticipated devaluation. However, it is important to keep in mind that the exchange rate change $\bar{e}^A$ is endogenously derived as a function of the monetary stances in all countries.[24]

Throughout the analysis, *the Center is assumed to maintain its monetary stance unchanged*, regardless of external developments. This assumption allows us to focus on country B, whose monetary authority may also devalue following country A's devaluation. In particular, we consider three possible policy scenarios for country B:

- a policy of monetary stabilization ($\bar{m}^B = 0$), hereinafter referred to as **MST**;
- the defense of the current exchange rate level *vis-à-vis* the Center ($\bar{e}^B = 0$), referred to as **PEG**; and
- a devaluation of the exchange rate in order to maintain unaltered country B's market share in the Center ($\bar{e}^B = \bar{e}^A$), an option referred to as **DEV**.

Formally, we outline the key implications of the three policy regimes in Table 4. In the next paragraphs, we discuss intuitively the main features of each policy scenario.[25]

[23] It can be shown that in our model the nominal exchange rates adjust on impact to nominal shocks, and no overshooting occurs in spite of the presence of price sluggishness: $e^j = \bar{e}^j$. Similarly, it can be shown that the net-asset position of a country — and its current account — adjusts instantaneously to the shocks: $b^j = \bar{b}^j$.

[24] Alternatively, we could proceed by taking $\bar{e}^A$ as given and determining endogenously the monetary policy $\bar{m}^A$ as a function of worldwide developments. The two strategies are qualitatively similar.

[25] An appendix with the algebraic details of the model is available upon request.

Table 4: International effects of country A's devaluation

MST regime

$$\bar{m}^B_{\mathbf{MST}} = 0, \qquad \bar{e}^B_{\mathbf{MST}} = [\Pi(\rho) - \Pi(\psi)]\,\gamma_A \bar{m}^A > 0$$

$$\bar{e}^A_{\mathbf{MST}} = [\gamma_A \Pi(\rho) + (1-\gamma_A)\,\Pi(\psi)]\,\bar{m}^A > 0, \quad \bar{e}^A_{\mathbf{MST}} - \bar{e}^B_{\mathbf{MST}} = \Pi(\psi)\,\bar{m}^A > 0$$

$$\frac{\bar{b}^P_{\mathbf{MST}}}{1-\gamma_P} = \frac{2\beta(\rho-1)}{1+\beta+\rho(1-\beta)}\gamma_A \bar{m}^A, \qquad \bar{b}^A_{\mathbf{MST}} - \bar{b}^B_{\mathbf{MST}} > 0$$

PEG regime

$$\bar{m}^B_{\mathbf{PEG}} = -\frac{\Pi(\rho) - \Pi(\psi)}{\gamma_A \Pi(\psi) + (1-\gamma_A)\,\Pi(\rho)}\gamma_A \bar{m}^A < 0, \qquad \bar{e}^B_{\mathbf{PEG}} = 0$$

$$\bar{e}^A_{\mathbf{PEG}} = \bar{e}^A_{\mathbf{PEG}} - \bar{e}^B_{\mathbf{PEG}} = \frac{\Pi(\psi)}{\gamma_A \Pi(\psi) + (1-\gamma_A)\,\Pi(\rho)}\Pi(\rho)\,\bar{m}^A > 0$$

$$\frac{\bar{b}^P_{\mathbf{PEG}}}{1-\gamma_P} = \frac{2\beta(\rho-1)}{1+\beta+\rho(1-\beta)}\frac{\Pi(\psi)}{\gamma_A \Pi(\psi) + (1-\gamma_A)\,\Pi(\rho)}\gamma_A \bar{m}^A, \quad \bar{b}^A_{\mathbf{PEG}} - \bar{b}^B_{\mathbf{PEG}} > 0$$

DEV regime

$$\bar{m}^B_{\mathbf{DEV}} = \bar{m}^A > 0, \qquad \bar{e}^B_{\mathbf{DEV}} = \Pi(\rho)\,\bar{m}^A > 0$$

$$\bar{e}^A_{\mathbf{DEV}} = \Pi(\rho)\,\bar{m}^A > 0, \qquad \bar{e}^A_{\mathbf{DEV}} - \bar{e}^B_{\mathbf{DEV}} = 0$$

$$\frac{\bar{b}^P_{\mathbf{DEV}}}{1-\gamma_P} = \frac{2\beta(\rho-1)}{1+\beta+\rho(1-\beta)}\bar{m}^A, \quad \bar{b}^A_{\mathbf{DEV}} - \bar{b}^B_{\mathbf{DEV}} = 0$$

Notes : The function Π is defined as:

$$\Pi(x) = \frac{1}{x}\frac{1-\beta+x(1+\beta)}{1+\beta+x(1-\beta)} > 0$$

Observe that $\Pi(\rho) > \Pi(\psi)$ if $\rho < \psi$.

3.1 Monetary stabilization (MST)

Under the **MST** regime, the devaluation by country A reduces the price of country A goods (shirts) relative to country B goods (sweaters), switching worldwide demand away from country B goods. It also reduces the relative price of the Periphery goods (textile) as a whole, switching worldwide demand away from the Center goods (computers). The nominal shock thus results in a reallocation of consumption in country B, with an ambiguous effect on its overall level, along the following lines:

- *Competition in the Center.* The consumers in the Center switch away from country B goods towards country A goods. They also shift away from Center goods to Periphery goods, but the former effect is stronger as there is more substitutability between Periphery goods (shirts *vs.* sweaters) than between Center and Periphery goods (computers *vs.* textiles). The demand switch in the Center therefore reduces the market share of country B exports. The fall in revenue from export sales in turn depresses country B consumption of Center goods.

- *Bilateral trade.* As the prices of country A goods in country B fall after the devaluation, country B's residents benefit from an improvement of their terms of trade,[26] allowing them to finance a higher level of consumption for any given nominal income.

Under the **MST** regime, the exchange rate of country B depreciates against the Center. Intuitively, this is because the consumption switch towards country A goods reduces the demand for country B currency. However, the fall in money demand is not large enough to depreciate the currency of country B against the currency of country A.

3.2 Unilateral peg (PEG)

Under the **PEG** regime country B must defend its currency, a goal that is achieved through a monetary contraction. Notably, however, the fall in $\bar{m}^B$ does not offset the increase in $\bar{m}^A$, so that the net Periphery-wide monetary stance is expansionary. Given $\bar{m}^A$, the equilibrium devaluation of A is lower under the **PEG** scenario than under the **MST** scenario, in which the

[26] The terms of trade are defined as the ratio between the prices of foreign and domestic goods expressed in local currency terms.

monetary authorities of country B do not contract $\bar{m}^B$ and let the currency depreciate.

The monetary tightening has a direct contractionary effect in country B. Moreover, by further appreciating the exchange rate against country A, it causes additional losses of market share in the Center. On the benefit side, it leads to a larger improvement of the terms of trade *vis-a-vis* country A.

3.3 Matching devaluations (DEV)

The central bank of country B may also decide to match the rate of country A devaluation (the **DEV** regime), so as to preserve the market share of country B exporters to the Center. Such a policy further reduces the relative price of Periphery goods, and amplifies the consumption switch away from the Center goods. The Center demand for country B exports rises, preventing a contraction of the imports of Center goods by country B households. Clearly, no change in the intra-Periphery terms of trade takes place.

3.4 A comparison across regimes

Three corollaries of our results are worth stressing. First, since the equilibrium exchange rate depreciation in country A is also a function of the policy stance in country B, in general, *for a given monetary shock in country A, the larger the depreciation of country B, the larger the depreciation of country A in equilibrium.*[27] This *feedback* effect of a devaluation in country B on the equilibrium depreciation of the exchange rate of country A, the country from which the shock itself originates, is one of the elements that contributes to exchange rate contagion across countries by magnifying the original competitive impulse.

The second corollary concerns the current account response to the devaluation shock and leads to a re-visitation of the Marshall-Lerner-Robinson conditions within our micro-founded and intertemporal framework. Observe that the current account balance for the Periphery as a whole can be written

[27] A feedback effect is also present if we take as given the depreciation of the exchange rate of country A *vis-a-vis* the Center, and focus on the implied monetary shock. The larger the depreciation of country B exchange rate, the smaller the required monetary expansion in country A.

as:

$$\frac{\bar{b}^P}{1-\gamma_P} \equiv \bar{b}^P - \bar{b}^C = \frac{2\beta(\rho-1)}{1+\beta+\rho(1-\beta)}\bar{m}^P \tag{6}$$

which can be a surplus or a deficit depending on whether ρ is larger or less than one. *If $\rho > 1$, the Periphery as a whole runs a current account surplus vis-à-vis the Center when country A devalues.* The fall in the relative price of Periphery goods redirects consumption towards them; the extent of such consumption switch is large enough to raise sales revenue, despite the adverse movement in the terms of trade. In terms of the Marshall-Lerner-Robinson conditions, the price elasticity of net export from the Periphery is larger than one.

Moreover, as long as $\rho > 1$, the larger the monetary expansion in the Periphery, the larger its current account surplus. Thus, as shown in Table 4, when $\rho > 1$ *the current account balance of the Periphery is larger under the* ***DEV*** *regime, and smaller under the* ***PEG*** *regime.* Opposite results hold for $\rho < 1$.

The Periphery overall current account surplus is allocated differently between countries A and B. Formally we have:

$$\frac{\bar{b}^A - \bar{b}^P}{1-\gamma_A} \equiv \bar{b}^A - \bar{b}^B = \frac{2\beta(\psi-1)}{1+\beta+(1-\beta)\psi}\left(\bar{m}^A - \bar{m}^B\right)$$

As long as $\psi > 1$, *it is never the case that the current account of country A increases by less than the current account of country B.* Under the **DEV** regime both Periphery countries increase symmetrically their net asset positions against the Center. Under both the **MST** and the **PEG** regimes the current account effect is stronger for country A than for country B.

The third result regards employment and the level of economic activity. In our model, monetary shocks cannot affect world-wide aggregate variables in the long run, *i.e.* $\bar{y}^W = 0$. Therefore, a devaluation by country A has a lasting impact on national output levels only insofar as it changes the international distribution of wealth. If the elasticities of substitution between domestic and imported goods are all larger than one, *long-run production levels will be higher in the non-devaluing countries.*

Consider for instance long-run output in the Center. Formally, we have:

$$\frac{\bar{y}^C}{\gamma_P} = \bar{y}^C - \bar{y}^P = \frac{1}{2}\frac{1-\beta}{\beta}\frac{\bar{b}^P}{1-\gamma_P} \tag{7}$$

As seen in equation (6), when $\rho > 1$ the Periphery runs a current account surplus. This implies that in the long run the Center has to increase production to service its debt, while the Periphery experiences an output contraction. An analogous result applies to long-run employment in the Periphery:

$$\bar{y}^A - \bar{y}^B = -\frac{1}{2}\frac{1-\beta}{\beta}\left(\bar{b}^A - \bar{b}^B\right)$$

Provided that $\psi > 1$, as discussed above, the current account in country B is never larger than the current account in country A, so that country B output in the long run is at least as large as in country A.

In the short run, however, these conclusions are reversed: because of the expenditure-switching effects of a devaluation, short-run employment will always increase more in the country that devalues more. For instance, *if* $\rho > 1$ *the prediction of the model conforms the traditional view, that the non-devaluing Center experiences a contraction in output in response to a monetary expansion and an exchange rate depreciation in the Periphery*:

$$y^C = -\gamma_P \frac{2\beta\left(\rho-1\right)}{1+\beta+\rho\left(1-\beta\right)}\bar{m}^P = -\rho\gamma_P \frac{2\beta\left(\rho-1\right)}{1-\beta+\rho\left(1+\beta\right)}\bar{e}^P \qquad (8)$$

It is only when the elasticity of substitution between Center and Periphery goods is smaller than unity that the short-run output in the Center may rise, despite the increase in its relative prices.

4 Current account, output, and welfare in the Center vs. the Periphery

Traditional models of competitive devaluations suggest that a drop in employment and the emergence of a current account deficit in neighboring countries are clear indicators of negative international repercussions from exchange rate shocks. When $\rho > 1$, for instance, a monetary expansion in the Periphery translates into a current account deficit (eq.7) and a short-run output contraction (eq.8) in the Center. Does this imply that the Center experiences a welfare loss when country A devalues?

Contrary to the conventional view, the answer is unambiguously no. One of the main advantages of our framework is the possibility to compute changes

in national welfare as measured by the utility of the average national household.[28] In other words, both positive and normative analyses are cast within a coherent, non-arbitrary choice-theoretic framework. In what follows u^j denotes approximate changes in per capita country j's indirect utility (1) relative to the initial equilibrium.[29] Under our maintained assumptions about elasticities, the Center country always benefits from the monetary expansion in the Periphery, both in absolute and in relative terms:

$$u^C = \frac{1}{\theta}\left[1 + \frac{\theta - \rho}{\rho}\frac{1+\rho}{1+\beta+\rho\,(1-\beta)}\right]\gamma_P \bar{m}^P > 0 \tag{9}$$

$$u^C - u^P = \frac{1}{\theta}\left[\frac{\theta - \rho}{\rho}\frac{1+\rho}{1+\beta+\rho\,(1-\beta)}\right]\bar{m}^P > 0 \tag{10}$$

It is easy to check that $\rho \leq \theta$ is a sufficient condition for the Center to experience a welfare gain in equation (9) — we could even relax our assumption and still get the same welfare result in absolute terms. Observe that if $\rho = \theta$, as in Obstfeld and Rogoff (1995, 1996), both Center and Periphery gain symmetrically from the devaluation of the Periphery.[30]

Intuitively, in the short run the monetary expansion of the Periphery increases the availability of Periphery goods to the Center and contemporaneously improves the purchasing power of the Center's consumers. To take full advantage of the short-term improvements in their terms of trade, if $\rho > 1$ country C's agents borrow from the Periphery to finance a higher consumption level.[31]

Conversely, even when it runs a current account surplus, the Periphery as a whole does not necessarily gain welfare. Evaluating u^P, the weighted average of welfare levels in countries A and B, we obtain

$$u^P = \Phi_P \bar{m}^P$$

[28] As customary in the literature, throughout the paper we only refer to welfare effects unrelated to liquidity services, implicitly assuming that χ is relatively small.

[29] Formally, $u^j \approx U_1^j - U_0^j$ where U_0^j is before-shock per-capita welfare and U_1^j is after-shock per-capita welfare in country j.

[30] The assumption that $\rho \leq \theta$ implies that by expanding its output the Periphery is not better off relatively to the Center, because the additional consumption financed by the additional sales revenue is not large enough to outstrip the additional cost of effort. Obstfeld and Rogoff (1995, 1996) consider the case $\rho = \theta$. Corsetti and Pesenti (1997) consider the case $1 = \rho < \theta$. Tille (1999) studies the general case.

[31] Similar considerations hold if $\rho \leq 1$, noting that in this case the Center can achieve a higher level of consumption without becoming a net borrower.

where

$$\Phi_P \equiv \gamma_P - (1-\gamma_P)\frac{\theta-\rho}{\rho}\frac{1+\rho}{1+\beta+\rho(1-\beta)} \lessgtr 0$$

The important result that, in an open economy, a monetary expansion can have a *beggar-thyself* effect rather than a *beggar-thy-neighbor* effect has been emphasized in the models of Corsetti and Pesenti (1997) and Tille (1999). The argument is as follows. In equilibrium, output and consumption are suboptimally low due to monopolistic distortions. In the short run, a monetary transfer from the government to the households leads Periphery agents to supply more labor and produce more goods. However, the induced terms of trade deterioration reduces the purchasing power of their incomes: the benefits from higher consumption accrue principally to the rest of the world, while the costs from additional labor efforts are concentrated in the Periphery.

In the context of our analysis, the possibility of a *beggar-thyself* devaluation arises when γ_P is relatively small (that is, the effective economic 'size' of the Periphery as measured by the share of Periphery goods in world consumption is negligible), when θ is relatively large (that is, the Periphery economy is sufficiently close to its competitive level, so that unanticipated monetary expansions cause the terms of trade to deteriorate with little improvement in efficiency), and when ρ is sufficiently small (that is, there is little substitutability between Center and Periphery, so that a devaluation by the Periphery increases the relative price of imports in the Periphery itself but has a limited impact on the Center's demand for Periphery goods).

5 The welfare foundations of competitive devaluations

We now focus on the conditions under which a devaluation by A deteriorates national welfare in B, and the conditions under which country B is better off by matching country A's devaluation. To address this issue, we start by expressing changes in country B welfare as a weighted sum of a Periphery-wide welfare component, and an intra-Periphery utility-transfer component:

$$u^B = \frac{1}{\theta}\Phi_P\left(\bar{m}^P\right) - \frac{1}{\theta}\gamma_A\Phi(\bar{m}^A - \bar{m}^B)$$

where the parameter Φ is to be defined below. The first term on the right hand side is the Periphery-wide change in welfare following a monetary expansion in any of the countries in the region. As discussed in the previous section, the impact may or may not be beneficial, depending on Φ_P being positive or negative. The second term can be interpreted as the intra-Periphery redistribution of utility stemming from asymmetric monetary expansions.

Under our assumptions for the consumption elasticities, an asymmetric monetary shock ($\bar{m}^A - \bar{m}^B > 0$) never redistributes utility from country B to country A:

$$\Phi \equiv \frac{\psi - \theta}{\psi} \frac{1 + \psi}{1 + \beta + \psi (1 - \beta)} < 0$$

In other words, after a devaluation of country A's currency, the improvement in country B's terms of trade always compensates for the loss of export volume, so that $u^B \geq u^A$.

We can now analyze changes in country B's welfare under the policy scenarios described above. Consider first the case in which $\bar{m}^B = 0$, *i.e.* the **MST** regime. The welfare change is:

$$u^B_{\mathbf{MST}} = \gamma_A (\Phi_P - \Phi) \bar{m}^A \lesseqgtr 0$$

As Φ is unambiguously negative, $u^P < 0$ is a necessary condition for $u^B_{\mathbf{MST}}$ to be negative: a *monetary and exchange rate shock in country A can hurt country B only if the Periphery as a whole loses against the Center.*

Intuitively, country A's devaluation is *beggar-thy-neighbor* when, first, consumers in the Center do not perceive substantial differences between imports from country A or B, so that the Periphery countries' market shares in the Center are highly sensitive to changes in prices (ψ is sufficiently close to θ); second, the Periphery as a whole is too small *vis-a-vis* the Center to reap significant consumption gains from the increase in Periphery-wide economic activity in the short run (γ_P is relatively small); and, third, there is little substitutability between Center and Periphery goods (ρ is relatively small), so that the improvement in country B's terms of trade against country A cannot go too far in offsetting the deterioration of country B's terms of trade against the Center.[32]

[32] The NBER working paper version of this paper (Corsetti, Pesenti, Roubini and Tille (1999)) includes a simplified model of competitive devaluations along these lines.

The sign of Φ_P will similarly determine the welfare incentives for country B to engineer a devaluation after the nominal shock in country A. By rearranging the above expression, country B will prefer a regime $\mathcal{X}$ over a regime $\mathcal{Z}$ if the following condition holds:

$$\left[\left(1-\gamma_A\right)\Phi_P+\gamma_A\Phi\right]\left(\bar{m}^B_{\mathcal{X}}-\bar{m}^B_{\mathcal{Z}}\right)>0 \tag{11}$$

If the expression in squared brackets is positive, country B always prefers the regime involving the largest monetary expansion, which is **DEV**. If the inequality sign is reversed, the best option for B is instead to maintain the peg with the Center. Not surprisingly, doing nothing (**MST)** is always dominated, by either **PEG** or **DEV**.

Interpreting the expression (11), country A's devaluation is 'contagious' only when country B's terms of trade externalities are negligible: for instance, when all national goods are highly substitutable worldwide, or when country B is sufficiently large relative to its trading partners. The key conclusion of our analysis can thus be stated as follows: *if the degree of exchange-rate pass-through is rather high, there is a non-negligible range of elasticity values for which country B does not have a welfare incentive to match country A's devaluation.*

An important empirical implication of our analysis is that, to the extent that exchange rate devaluations have an impact on relative prices according to the prediction of the law of one price, *intra-Periphery trade reduces the risk of exchange rate contagion from country A to country B*. In fact, it is possible to construct a modified setup in which households in the Periphery countries consume only goods produced in the Center and in their own country,[33] so that the only link between country A and country B is through export competition in the Center market.

In such a case, a devaluation by country A still reduces the market share of country B's exports in the Center, but no longer has a direct beneficial effect on country B's terms of trade. The devaluation then has a more adverse impact on the welfare of country B than in the case with a direct trade link. Country B also has a stronger incentive to devalue in turn: as country B does not import any goods from country A, a monetary expansion does not result in a deterioration of its terms of trade *vis-a-vis* country A. Yet, even in the model without intra-Periphery trade the possibility remains that the

[33] In the consumption basket for the households in the periphery countries, C_P^A and C_P^B are replaced by C_A^A and C_B^B respectively. A detailed analysis is available upon request.

adverse impact of inflation in country B be large enough to offset the gain of defending its export market share in the Center.

6 The role of deviations from the law of one price

As emphasized in the previous section, the assumptions about firms' pricing behavior and exchange rate pass-through are key to our results. In this section we re-visit our analysis under the assumption that, in the short run, prices are predetermined in terms of the *buyer*'s currency.[34] In other words, short-run changes in the nominal exchange rate are not transmitted to consumer prices abroad, but absorbed by the producer's profit margins. The absence of exchange rate pass-through implies that the law of one price does not necessarily hold across national markets following monetary shocks.[35] Under this new assumption, a central result of the previous section is turned upside down: *country B always has an incentive to match country A's devaluation against the Center, as its consumption utility does not change but rather its labor effort disutility worsens.*

When prices are set in the buyer's currency, the current account does not respond to nominal shocks in country A, so that these have no long-run effects.[36] Since all consumer prices are constant in the short run, an increase in nominal balances in country A raises real balances and drives up country A consumption one-to-one, but has no effect on consumption in the rest of the world. Note that, at constant relative prices, households in country A increase consumption symmetrically across all goods. Thus, to satisfy the additional demand from A, output must increase worldwide in proportion to the change in nominal balances.

Formally, we can write:

$$c^j = \bar{m}^j \qquad y^j = y^W = \bar{m}^W \qquad j = A, B, C$$

[34] As a reminder, $P_k^j(z)$ are predetermined for all $j, k = A, B, C$.

[35] The demand elasticities being the same in all markets, the law of one price holds *ex ante*.

[36] Formally, $\bar{b}^A = \bar{b}^B = \bar{b}^C = 0$, $\bar{c}^P - \bar{c}^C = \bar{p}_P^P - \bar{p}_C^C - \bar{e}^P = \bar{y}^P - \bar{y}^C = 0$, $\bar{c}^A - \bar{c}^B = \bar{p}_A^A - \bar{p}_B^B - \left(\bar{e}^A - \bar{e}^B\right) = \bar{y}^A - \bar{y}^B = 0$. It is worth emphasizing that this result is a consequence of our assumption of a logarithmic utility for consumption. Together with several other generalizations, the extension of our framework to an elasticity of intertemporal substitution different from unity is left to future contributions.

Moreover, it can be shown that exchange rate depreciation is given by:

$$\bar{e}^j = \bar{m}^j$$

As in each country consumption only responds to domestic money, by devaluing its own currency any country is able to increase its own consumption, raising output proportionally worldwide.

From these results, it is straightforward to derive the welfare effect in country j:

$$u^j = \bar{m}^j - \frac{\theta - 1}{\theta}\bar{m}^W$$

Note that, if all countries expand their money supply symmetrically, they all benefit by $\bar{m}^W/\theta$. If however a single country does not expand its money supply along with the others, that country is unambiguously worse off, since its residents must supply more labor at an unchanged consumption level.

The previous expressions imply that the **MST** and **PEG** regimes are identical, and country B is unambiguously worse-off when it pursues either of these policy options:

$$u^B_{\textbf{MST, PEG}} = -\frac{\theta - 1}{\theta}\gamma_A\gamma_P\bar{m}^A < 0$$

Only when country B chooses the option **DEV** ($\bar{m}^B = \bar{m}^A$) it is able to achieve a welfare gain:

$$u^B_{\textbf{DEV}} = \bar{m}^A - \frac{\theta - 1}{\theta}\gamma_P\bar{m}^A > \frac{1}{\theta}\bar{m}^A > 0$$

Intuitively, when prices are set in the buyer's currency, a monetary expansion by country A results in both a nominal and a real devaluation of its currency. A devaluation thus raises the real revenue from exports, to the benefit of the households of country A. At the same time, it reduces the real revenue from net exports symmetrically in all other countries. Country A's devaluation is therefore *beggar-thy-neighbor*. Because of the fall in export revenues and profits, the households in the countries that do not devalue are required to work more to sustain the initial level of consumption. The conclusions are quite striking relative to those derived under the law of one price: *by symmetrically devaluing, both Periphery countries can increase their welfare at the expense of the Center.*

Notice that, when the law of one price does not hold, the incentive for country B to match country A's devaluation entirely reflects its direct trade linkage with country A. *If the Periphery countries did not trade with each other and were only linked through the Center, country B would be unaffected by country A's devaluation and would have no incentive to respond.*

This is because, in the absence of intra-Periphery trade, a rise in country A's money supply leads households to increase their purchases of consumption goods, of which country B goods are not part. All consumer prices being preset, country B's consumption in the short run depends only on its nominal balances. As country B's households only produce for their own consumption or to export towards the Center, country B's output in the short run depends on its own monetary stance, along with the Center's:

$$c^B = \bar{m}^B,\ y^B = \gamma_P \bar{m}^B + (1 - \gamma_P)\, \bar{m}^C.$$

Country B is therefore entirely insulated from the devaluation in country A. There is *no beggar-thy-neighbor* effect, and no incentive to devalue in turn.

Note that the role of intra-Periphery trade in determining country B's incentive to match country A's devaluation crucially depends on whether the law of one price holds or not. *A direct trade link within the Periphery reduces the incentive for country B to devalue when there is full exchange-rate pass-through, whereas the opposite is true when there is no pass-through at all.*

7 Conclusions

This paper has reconsidered the logical foundations of competitive devaluations by studying the international transmission of exchange rate shocks in a cohesive choice-theoretic framework. We have analyzed both the impact of a devaluation by a country on its neighbors, and the incentive for them to devalue in turn.

While several positive predictions of our analysis are consistent with the traditional policy model of competitive devaluations, our assessment of their normative implications is in general sharply different from the conventional view. For instance, if the Marshall-Lerner-Robinson conditions hold, our model predicts that a devaluation by one country translates into a reduction of employment and a current account deficit abroad. Yet, it does not predict that such a devaluation is *beggar-thy-neighbor*, *i.e.* that it reduces the utility

of the national representative household in neighboring countries. Key to this result is the fact that neighbor countries benefit from an improvement in their terms of trade — an issue overlooked by the standard open-economy model. In terms of welfare, the improvement of the terms of trade can more than offset the reduction in output.

Specifically, when the degree of exchange rate pass-through is high, a devaluation allows domestic producers to increase their market shares in a third country at the expense of other competitors. Yet a high degree of pass-through also translates into a fall in their relative prices. Because of the latter effect, bilateral trade between countries which compete in the world economy reduces the incentive to resort to exchange rate policy as a means to enhance competitiveness.

Conversely, a low degree of pass-through increases the likelihood that a devaluation be competitive, but for reasons that are substantially different from the ones highlighted by the traditional model. As relative prices in national currencies are insulated from exchange rate movements, a devaluation raises exporters' profits and domestic real incomes, so that domestic households can increase their consumption. Since the higher demand is met by foreign producers at unchanged consumer prices, they experience a loss in sale revenue. A devaluation is therefore *beggar-thy-neighbor* as it implies that foreign producers must now work more for any given level of consumption.

Moving toward a comprehensive theory of competitive devaluations, a few additional issues could be studied by extending our framework. An important one left to future research, for instance, concerns the welfare implications of exchange rate movements in the presence of external debt denominated in foreign currency and nominal rigidities. Also, by replacing the perfect-foresight approach with a full stochastic analysis it will be possible to account for the effects of exchange rate risk on firms' pricing behavior and consumer allocation. Yet, the next crucial step in the analysis will consist of adopting a game-theoretical approach, so as to focus more directly on strategic interactions and non-cooperative equilibria across countries. The structure of international spillovers and the micro-foundations of the mechanism of policy transmission discussed in this paper are meant to provide the building blocks for a development of the analysis in such direction.

References

[1] Baig, Taimur, and Ilan Goldfajn (1998) "Financial market contagion in the Asian crisis", International Monetary Fund Working Paper Series.

[2] Buiter, Willem, Giancarlo Corsetti and Paolo Pesenti (1998 a). *Financial markets and European monetary cooperation. The lessons of the 1992-93 Exchange Rate Mechanism crisis.* Cambridge, UK: Cambridge University Press.

[3] Buiter, Willem, Giancarlo Corsetti and Paolo Pesenti (1998 b). "Interpreting the ERM crisis: country-specific and systemic issues." *Princeton Studies in International Finance* No.84, International Finance Section, Princeton University, March.

[4] Calvo, Guillermo (1998). "Understanding the Russian virus (with special reference to Latin America)", University of Maryland, mimeo.

[5] Calvo, Guillermo, and Enrique Mendoza (1997). "Rational contagion and the globalization of securities markets," mimeo, October.

[6] Caramazza, Francesco, Luca Ricci and Ranil Salgado (1999). "Trade and financial contagion in currency crises," International Monetary Fund Working Paper Series, forthcoming.

[7] Chari V.V. and Patrick Kehoe (1997). "Hot money." National Bureau of Economic Research Working Paper No.6007, April.

[8] Corsetti, Giancarlo, and Paolo Pesenti (1997). "Welfare and macroeconomic interdependence." National Bureau of Economic Research Working Paper No.6307, December.

[9] Corsetti, Giancarlo, Paolo Pesenti, and Nouriel Roubini (1999 a). "What caused the Asian currency and financial crisis?" *Japan and the World Economy*, forthcoming.

[10] Corsetti, Giancarlo, Paolo Pesenti, and Nouriel Roubini (1999 b). "Paper tigers? A model of the Asian crisis." *European Economic Review*, forthcoming.

[11] Corsetti, Giancarlo, Paolo Pesenti, Nouriel Roubini and Cédric Tille (1999). "Competitive devaluations: a welfare-based approach." National Bureau of Economic Research Working Paper No.6889, January.

[12] Devereux, Michael, and Charles Engel (1998). "Fixed vs. floating exchange rates: how price setting affects the optimal choice of exchange-rate regime," University of Washington, mimeo.

[13] Drazen, Allan (1998). "Political contagion in currency crises," University of Maryland, mimeo.

[14] Eichengreen, Barry, Andrew K. Rose and Charles Wyplosz (1996). "Contagious currency crises." National Bureau of Economic Research Working Paper No.5681, July.

[15] Eichengreen, Barry, and Charles Wyplosz (1993). "The unstable EMS." *Brookings Papers on Economic Activity* 1, pp.51-143.

[16] Fernald, John, Hali Edison and Prakash Loungani (1998). "Was China the first domino? Assessing links between China and the rest of emerging Asia." Federal Reserve Board, International Finance Discussion Paper No.604, March.

[17] Forbes, Kristin, and Roberto Rigobon (1998). "Measuring stock market contagion: conceptual issues and empirical tests," MIT, mimeo

[18] Glick, Reuven, and Andrew K. Rose (1998) "Contagion and trade: why are currency crises regional?" Centre for Economic Policy Research Discussion Paper No.1947.

[19] International Monetary Fund (1997). *World economic outlook. Interim assessment.* Washington, DC: International Monetary Fund, December.

[20] International Monetary Fund (1998a). *World economic outlook.* Washington, DC: International Monetary Fund, May.

[21] International Monetary Fund (1998b). *International capital markets.* Washington, DC: International Monetary Fund, September.

[22] Kaminsky, Graciela and Carmen M. Reinhart (1997). "The twin crises: the causes of banking and balance-of-payments problems," mimeo, Federal Reserve Board.

[23] Kaminsky, Graciela and Carmen M. Reinhart (1998). "On crises, contagion, and confusion," mimeo, University of Maryland.

[24] Kenen, Peter B. (1985). "Macroeconomic theory and policy: how the closed economy was opened," in Ronald W. Jones and Peter B. Kenen (eds.), *Handbook of international economics*, Vol.II, Amsterdam: North-Holland, pp.625-678.

[25] Liu, Ligang, Marcus Noland, Sherman Robinson, and Zhi Wang (1998). "Asian competitive devaluations." Institute for International Economics Working Paper 98-2.

[26] Masson, Paul (1998). "Contagion: monsoonal effects, spillovers and jumps between multiple equilibria," International Monetary Fund, mimeo.

[27] Nurkse, Ragnar (1944). *International currency experience. Lessons of the inter-war period.* Geneva: League of Nations.

[28] Obstfeld, Maurice, and Kenneth Rogoff (1995). "Exchange rate dynamics redux." *Journal of Political Economy* 103, pp.624-660.

[29] Obstfeld, Maurice and Kenneth Rogoff (1996). *Foundations of international macroeconomics*. Cambridge, MA: MIT Press.

[30] Obstfeld, Maurice and Kenneth Rogoff (1998). "Risk and exchange rates", National Bureau of Economic Research Working Paper No. 6694, August.

[31] Sachs, Jeffrey, Aaron Tornell and Andres Velasco (1996). "Financial crises in emerging markets: the lessons of 1995." *Brookings Papers on Economic Activity* No.1, 147-217.

[32] Tille, Cédric (1999). "The role of consumption substitutability in the international transmission of shocks," Federal Reserve Bank of New York Staff Report No.67, March.