

Assessing the Welfare Gains of Trade Integration in the European Monetary Union*

Aurélien Eyquem[†] Jean-Christophe Poutineau[‡]

First version: June 2006. This version: July 2007

Abstract

This paper evaluates the welfare gains arising from the deeper trade integration observed in Europe since the adoption of the Euro. In an intertemporal general equilibrium macroeconomics model with incomplete financial markets and sticky prices, we find that reaching a complete trade and financial integration in the area may imply up to a 100% increase in permanent consumption for a constant labor effort. We underline the optimality of a greater integration in the trade of intermediate goods and we show that the reduction of asymmetries in the pattern of nominal rigidities has a marginal effect. In contrast, the increase in horizontal trade induces some welfare losses since it leads to a suboptimal adjustment of the current account in the short run which has a long run negative impact on resources allocation in the monetary union.

J.E.L.: F32, F41, F47

Keywords: Trade Integration, Welfare Analysis, Optimal Currency Areas, Production Fragmentation.

*We would like to thank participants of the RIEF Meeting in Rome and participants of the 24th Symposium in Money, Banking and Finance in Rennes for helpful comments. The traditional disclaimer applies.

[†]CREM, Université de Rennes 1, 7 Place Hoche, 35065 Rennes Cedex, France. *Tel*: +33.2.23.23.35.58. *E-mail*: aurelien.eyquem@univ-rennes1.fr.

[‡]CREM, Université de Rennes 1, 7 Place Hoche, 35065 Rennes Cedex, France, and Ecole Normale Supérieure de Cachan. *Tel*: +33.2.23.23.33.58. *E-mail*: jean-christophe.poutineau@univ-rennes1.fr.

Introduction

The trade impact of the Euro is now widely documented in the literature.¹ Although the actual value of the "Rose effect" is still under debate for the European Monetary Union (EMU), most contributions underline (*i*) the significant impact of the common currency on the members' mutual trade flows and (*ii*) the associated increase in the efficiency of resources allocation. This last aspect is widely agreed, although the literature still lacks a quantitative assessment of these gains.

In this paper we assess the reality of these efficiency gains in an intertemporal general equilibrium macroeconomics model. Building on the recent developments of the New Open Economy Macroeconomics (NOEM), we characterize the current European situation in an estimated two-country monetary union featuring (*i*) incomplete financial markets, (*ii*) home bias in both households preferences and producers technologies, (*iii*) Calvo type sticky prices, and (*iv*) asymmetric productivity and public spending shocks.

The first assumption accounts for the potential gains related to a deeper financial integration and restores the current account as an external adjustment channel. The second assumption accounts for the role of a deeper trade integration. In our model, a reduction of home biases in consumption and production bundles is respectively isomorphic to an increase in mutual trade openness for final and intermediate goods. The assumption of (asymmetrically) staggered prices introduces a disconnection with respect to the natural equilibrium, which is costly in terms of welfare. In our model, welfare gains of a deeper integration are related to the impact of trade on the distance between the sticky price and the natural equilibrium. Finally, in the spirit of optimal currency area theory, asymmetric productivity and public spending shocks imply asymmetric responses of output, inflation, consumption and hours. In a monetary union, the absence of nominal exchange rates to adjust these idiosyncrasies is costly.

We estimate the parameters of the model on EMU data and evaluate the consequences of a reduction in these goods market asymmetries on cross border consumption risk-sharing and on the intertemporal allocation of resources in the monetary union. We get two main results.

First, we show that the situation of perfectly integrated financial and goods markets in the euro area implies sizeable welfare gains, equivalent to a doubling of members permanent con-

¹Reviewing the trade effect of currency unions Baldwin (2006) provides an up to date survey for Europe. He considers that at the bottom line the Euro did boost intra Eurozone trade by something like five to ten per cent on average although this effect is sensitive to the arrival of new data.

sumption for a constant work effort. These gains represent the potential total efficiency gains to be obtained by reaching the (pareto-optimal) situation where financial markets are complete and all consumption, production and price setting behavior are similar across countries.

Second, the increase of intermediate and final goods trade are not substitutes in terms of welfare gains when financial markets are incomplete. An increase in the mutual trade of final goods improves significantly consumption pooling but deteriorates the intertemporal allocation of resources. Inversely, an increase in the mutual trade of intermediate goods improves the welfare but has a limited impact on consumption pooling.

As an example, a 1% deeper integration of the final goods markets improves cross-border risk sharing by 1.21% but deteriorates the intertemporal allocation of resources by an equivalent 2.00% reduction in permanent consumption. This caveat rests on the combination of price stickiness and incomplete financial markets. In such a situation, a reduction in home bias increases the role of the current account to adjust asymmetric national shocks, so that agents share more easily cross-border wealth. Taking an intertemporal perspective, this initial adjustment requires a long run disconnection of output - and asymmetries in the agents' labour effort - to meet the intertemporal budget constraint of agents in this country. As long as prices are sticky, the suboptimal adjustment of the current account in the short run has a long run negative impact on resources allocation in the monetary union.

In contrast, a 1% further integration of the intermediate goods market, leads to a 0.21% reduction in relative consumption fluctuation but improves the intertemporal resources allocation by an equivalent increase of 7.51% in permanent consumption. In our model, since the integration of the intermediate goods market is isomorphic to production fragmentation, asymmetric shocks are more symmetrically shared in the monetary union. As a consequence, agents are less prone to use the current account to adjust less asymmetrical shocks on consumption. More homogeneous production processes reduce terms of trade fluctuations and output differentials, which is welfare improving in the monetary union.

The paper is organized as follows: the second section describes a NOEM model of an imperfectly integrated and asymmetric monetary union. The third section solves the model in logdeviation and provides estimates for the parameters using the Simulated Method of Moments on European data. The fourth section is devoted to the analysis of welfare issues. The last section concludes.

1 An Imperfectly Integrated Monetary Union

The model describes a two-country world with a common currency. Each nation represents half of this monetary union. It is populated by N infinitely-living households, a government, and firms producing intermediate and final goods. All goods are traded. Monetary policy is delegated to the central bank of the monetary union which controls the interest rate. The international financial market is incomplete and agents only trade one period composite bonds. Nominal exchange rate issues per se as well as the analysis of the conditions underlying the adoption of a common currency are beyond the scope of this paper.

1.1 Households and National Governments

In each country the number of infinitely-living households is normalized to one. The representative household $j \in [0, 1]$ of nation $i \in \{h, f\}$ maximizes a welfare index $\Omega_t^i(j)$,

$$\Omega_t^i(j) = \sum_{s=t}^{\infty} \beta^{s-t} E_t \left\{ \frac{C_s^i(j)^{1-\rho}}{1-\rho} - \frac{N_s^i(j)^{1+\psi}}{1+\psi} \right\}, \quad (1)$$

subject to,

$$B_{t+1}^i(j) - R_t B_t^i(j) = W_t^i N_t^i(j) + \Pi_t^i(j) - P_t^i C_t^i(j) - T_t^i(j) - P_{i,t} A C_t^i(j), \quad (2)$$

and the following transversality condition,

$$\lim_{T \rightarrow \infty} \Pi_{\tau=t}^T R_{\tau}^{-1} E_t \{ B_{T+1}^i(j) \} = B^i(j).$$

In Eq. (1), $\beta = (1 + \delta)^{-1}$ is the subjective discount factor, ρ is the index of risk aversion, ψ^{-1} is the Frischian elasticity, $C_t^i(j)$ is the aggregate consumption bundle chosen by the representative agent and $N_t^i(j)$ is the quantity of labour of type j that is competitively supplied by the agent to the intermediate firm of country i . As in Beetsma and Jensen (2005), we do not introduce money holdings in the utility function since money market plays no role for the dynamics when the nominal interest rate is the monetary policy instrument.²

In Eq. (2), $B_t^i(j)$ is the holding of the composite one period real bond by the agent of country i at the end of period $t - 1$ that pays a gross nominal rate of interest R_t between periods $(t - 1)$ and t , $W_t^i(j)$ is the nominal wage corresponding to type j labour in country i in

²When controlling the nominal interest rate, money is endogenously supplied by central banks and money demands are only useful to provide general price level determinacy.

period t , $\Pi_t^i(j) = \int_0^1 \Pi_t^i(k, j) dk$ is the profit paid by final firms, $T^i(j)$ represents the amount of lump-sum taxes, P_t^i is the consumer price index in country i in period t and $P_{i,t}$ is the producer price index. Finally, $AC_t^i(j)$ represents quadratic portfolio adjustment costs defined according to,

$$AC_t^i(j) = \frac{\chi}{2} [B_{t+1}^i(j) - B^i(j)]^2,$$

where $B^i(j)$ is the steady state level of net foreign assets and χ is the cost of portfolio adjustment. Portfolio adjustment costs play a key role in the model since they provide a convenient way to balance the current account in the long run when the financial market is incomplete between nations (Schmitt-Grohé and Uribe, 2003). Here, buying (resp. selling) bonds affects negatively (resp. positively) the individualized national interest rates in the monetary union so that agents have a strong incentive to return to their initial financial position in the long run.

The Euler condition that solves Eqs. (1)-(2), is affected by portfolio adjustment costs,

$$E_t \{ P_{t+1}^i C_{t+1}^i(j)^\rho \} = \beta I_{t+1}^i P_t^i C_t^i(j)^\rho,$$

with, $I_{t+1}^i(j) = R_{t+1} [1 + \chi P_{i,t} (B_{t+1}^i(j) - B^i(j))]^{-1}$.³ The labour supply function depends on the level of consumption and on the real wage,

$$N_t^i(j)^\psi = \frac{W_t^i}{P_t^i C_t^i(j)^\rho}.$$

Assuming home bias in national consumption bundles, we define the aggregate consumption of consumer j living in country i , $C_t^i(j)$ and the companion consumption price index P_t^i as,

$$C_t^i(j) = [\alpha_i^{\alpha_i} (1 - \alpha_i)^{1 - \alpha_i}]^{-1} C_{H,t}^i(j)^{1 - \alpha_i} C_{F,t}^i(j)^{\alpha_i}, \quad P_t^i = (P_{H,t}^i)^{1 - \alpha_i} (P_{F,t}^i)^{\alpha_i},$$

where $(1 - \alpha_i) \in [\frac{1}{2}, 1]$ measures the consumption home bias in country i . Corsetti (2006) shows that $2\alpha_i$ is a relevant indicator of goods market openness. Following Obstfeld and Rogoff (2000), we suggest that the value of the home bias $(1 - \alpha_i)$ is related to trade costs between nations. Here, the existence iceberg shipping costs $c \in [0, 1]$ can be related to the

³The portfolio adjustment cost parameter (χ) affects the intertemporal consumption choice: an increase in the cost of bonds trading reduces the sensitivity of wealth's accumulation to a variation of the interest rate, as it becomes more costly to smooth consumption. A lower value of χ represents a better integration of the financial market as it increases the sensitivity of consumption to the interest rate.

size of home bias according to $\alpha_i = \frac{1-c}{2-c}$.⁴ In the rest of the paper we use the value of $2\alpha_i$ as a tractable proxy to measure the openness of trade. The consumption subindexes $C_{H,t}^i(j)$ and $C_{F,t}^i(j)$ are,

$$C_{H,t}^i(j) = \left[\int_0^1 C_{H,t}^i(k, j)^{\frac{\theta-1}{\theta}} dk \right]^{\frac{\theta}{\theta-1}}, \quad C_{F,t}^i(j) = \left[\int_0^1 C_{F,t}^i(k, j)^{\frac{\theta-1}{\theta}} dk \right]^{\frac{\theta}{\theta-1}},$$

where $C_{H,t}^i(k, j)$ (respectively $C_{F,t}^i(k, j)$) is the consumption of a typical final good k of country home (resp. foreign) by the representative consumer j of country i and $\theta > 1$ is the elasticity of substitution between national varieties of final goods. The corresponding price of domestic and foreign goods in country i are,

$$P_{H,t}^i = P_{H,t} = \left[\int_0^1 P_{H,t}(k)^{1-\theta} dk \right]^{\frac{1}{1-\theta}}, \quad P_{F,t}^i = P_{F,t} = \left[\int_0^1 P_{F,t}(k)^{1-\theta} dk \right]^{\frac{1}{1-\theta}}.$$

Finally, defining the terms of trade in the monetary union as $S_t = \frac{P_{F,t}}{P_{H,t}}$, we get,

$$C_t^i(k, j) = (1 - \alpha_i) \left[\frac{P_{H,t}(k)}{P_{H,t}} \right]^{-\theta} S_t^{\alpha_i} C_t^i(j), \quad C_t^i(k, j) = \alpha_i \left[\frac{P_{F,t}(k)}{P_{F,t}} \right]^{-\theta} S_t^{\alpha_i - 1} C_t^i(j).$$

Governments choose the amount of public spending on the final goods market and balance their budget constraint through lump-sum taxes according to,

$$\int_0^1 T^i(j) dj + \tau \int_0^1 P_{i,t}(k) Y_t^i(k) dk = P_{i,t} G_t^i,$$

where τ is a proportional subsidy to firms to offset the negative effects of monopolistic competition on final goods markets.⁵ We assume that national public spending are entirely home biased, *i.e.*, $G_t^i = \left[\int_0^1 G_t^i(k)^{\frac{\theta-1}{\theta}} dk \right]^{\frac{\theta}{\theta-1}}$. Finally, the level of aggregate public spending in country i evolves according to,

$$G_{t+1}^i = (1 - \epsilon_g) G_t^i + \epsilon_g G_t^i + \zeta_{g,t+1}^i$$

⁴In appendix A, we derive the general form of the relation between iceberg trade costs and home bias in consumption, even when the elasticity of substitution between home and foreign goods is non-unitary.

⁵Indeed, monopolistic competition distorts the first-best allocation through mark-up pricing and lower output levels in the economy. As shown by Benigno and Woodford (2005), optimal subsidy policy restores the optimal perfectly competitive allocation.

where $\zeta_{g,t}^i$ are I.I.D innovations with variances $\sigma(\zeta_{g,t}^i)^2$.

1.2 Firms

The production of final goods consists in a two step process. First, a firm in each country produces an homogeneous intermediate input that is internationally traded on a perfectly competitive market. The intermediate firm of country i combines national labour L_t^i with a given national productivity level A_t^i to produce a quantity of intermediate inputs $X_t^i = A_t^i L_t^i$, sold at price $\frac{W_t^i}{A_t^i}$, where,

$$A_{t+1}^i = (1 - \epsilon_a) A_t^i + \epsilon_a A_t^i + \zeta_{a,t+1}^i$$

and where $\zeta_{a,t}^i$ are I.I.D innovations with variances $\sigma(\zeta_{a,t}^i)^2$.

Intermediate inputs are then combined by final firms in the monetary union to produce consumption goods. We normalize the number of final firms to 1 in each economy. Thus, the representative final firm $k \in [0, 1]$ of nation $i \in \{h, f\}$ is the monopolistic provider of quantity $Y_t^i(k)$ of the k^{th} variety of final good in this economy according to,

$$Y_t^i(k) = [(1 - \gamma_i)^{1-\gamma_i} (\gamma_i)^{\gamma_i}]^{-1} X_{H,t}^i(k)^{1-\gamma_i} X_{F,t}^i(k)^{\gamma_i},$$

where $X_{H,t}^i(k)$ and $X_{F,t}^i(k)$ are input h and f consumptions of firm k that belongs to country i , and $(1 - \gamma_i) \in [0, \frac{1}{2}]$ measures the home bias on intermediate input use. Defining the intermediate inputs terms of trade as $\Sigma_t = \frac{W_t^f/A_t^f}{W_t^h/A_t^h}$, optimal input demands are,

$$X_{H,t}^i(k) = (1 - \gamma_i) \Sigma_t^{\gamma_i} Y_t^i(k), \quad X_{F,t}^i(k) = \gamma_i \Sigma_t^{\gamma_i - 1} Y_t^i(k),$$

and the marginal cost of firm k in country i , $MC_t^i(k)$, is given by,

$$MC_t^i(k) = MC_t^i = (W_t^f/A_t^f)^{1-\gamma_i} (W_t^h/A_t^h)^{\gamma_i}.$$

Since each firm is a monopolistic provider of the k^{th} variety of final good in its economy, the profit of firm k in country $i \in \{h, f\}$ writes,

$$\Pi_t^i(k) = [(1 - \tau) P_t^i(k) - MC_t^i] Y_t^i(k),$$

with,

$$Y_t^i(k) = \left[\frac{P_{i,t}(k)}{P_{i,t}} \right]^{-\theta} \left[C_{i,t}^h + C_{i,t}^f + G_t^i + AC_t^i \right],$$

and, $C_{H,t}^i = \int_0^1 C_{H,t}^i(j) dj$, $C_{F,t}^i = \int_0^1 C_{F,t}^i(j) dj$, $AC_t^i = \int_0^1 AC_t^i(j) dj$. Following Calvo (1983), a fraction $(1 - \eta^i)$ of firms located in country $i \in \{h, f\}$, sets new prices each period, with an individual firm's probability of re-optimizing in any given period being independent of the time elapsed since it last reset its price. Since households own firms, producers maximize the anticipated path of profits per units of wealth, *i.e.*,

$$\text{Arg max}_{P_{i,t}(k)} \sum_{v=0}^{\infty} (\eta^i \beta)^v E_t \left\{ \frac{Y_{t+\nu}^i(k)}{P_{t+\nu}^i C_{t+\nu}^i(j)^\rho} [(1 - \tau) P_{i,t}(k) - MC_{t+\nu}^i] \right\},$$

implying the optimal pricing policy $P_{i,t}^*(k)$,

$$P_{i,t}^*(k) = \frac{\theta}{(\theta - 1)(1 - \tau)} \frac{\sum_{v=0}^{\infty} (\eta^i \beta)^v E_t \left\{ \frac{Y_{t+\nu}^i(k) MC_{t+\nu}^i}{P_{t+\nu}^i C_{t+\nu}^i(j)^\rho} \right\}}{\sum_{v=0}^{\infty} (\eta^i \beta)^v E_t \left\{ \frac{Y_{t+\nu}^i(k)}{P_{t+\nu}^i C_{t+\nu}^i(j)^\rho} \right\}}.$$

Finally, aggregating among final firms and assuming behavioral symmetry of Calvo producers, the average price of a final good in nation $i \in \{h, f\}$ is,

$$P_{i,t} = \left[(1 - \eta^i) P_{i,t}^*(k)^{1-\theta} + \eta^i P_{i,t-1}^{1-\theta} \right]^{\frac{1}{1-\theta}}.$$

1.3 Markets Equilibrium

We solve the model assuming that each country is the mirror image of the other on the goods market. Posing $\alpha_h = \alpha$ we simply get $\alpha_f = 1 - \alpha$. Aggregating over goods and agents, and defining $Y_t^i = \left[\int_0^1 Y_t^i(k)^{\frac{\theta-1}{\theta}} dk \right]^{\frac{\theta}{\theta-1}}$, the equilibrium condition on the final goods markets writes,

$$\begin{aligned} Y_t^h &= (1 - \alpha) C_t^h S_t^\alpha + \alpha C_t^f S_t^{1-\alpha} + G_t^h + AC_t^h, \\ Y_t^f &= (1 - \alpha) C_t^f S_t^{-\alpha} + \alpha C_t^h S_t^{\alpha-1} + G_t^f + AC_t^f. \end{aligned}$$

On the intermediate goods market, posing $\gamma_h = \gamma$ implies that $\gamma_f = (1 - \gamma)$. The equilibrium on the intermediate goods markets is,

$$\begin{aligned} X_t^h &= X_{H,t}^h + X_{H,t}^f = (1 - \gamma) \Sigma_t^\gamma Y_t^h DP_t^h + \gamma \Sigma_t^{1-\gamma} Y_t^f DP_t^f, \\ X_t^f &= X_{F,t}^f + X_{F,t}^h = (1 - \gamma) \Sigma_t^{-\gamma} Y_t^f DP_t^f + \gamma \Sigma_t^{\gamma-1} Y_t^h DP_t^h, \end{aligned}$$

with, $X_{H,t}^i = \int_0^1 X_{H,t}^i(k)dk$, $X_{F,t}^i = \int_0^1 X_{F,t}^i(k)dk$. The term $DP_t^i = \int_0^1 \left[\frac{P_{i,t}(k)}{P_{i,t}} \right]^{-\theta} dk$ represents the Dispersion of Prices on the final goods market in country i . Aggregating over final firms, the macroeconomic production function simply writes for each nation $i \in \{h, f\}$,

$$Y_t^i DP_t^i = [(1 - \gamma_i)^{1-\gamma_i} (\gamma_i)^{\gamma_i}]^{-1} (X_{H,t}^i)^{1-\gamma_i} (X_{F,t}^i)^{\gamma_i}.$$

Since the labour market is fully segmented across nations, the equilibrium of this market is defined for each country $i \in \{h, f\}$ as,

$$N_t^i = \int_0^1 N_t^i(j) dj = L_t^i.$$

Finally, defining $B_t^i = \int_0^1 B_t^i(j) dj$ for $i \in \{h, f\}$, the financial equilibrium of the monetary union requires that,

$$B_t^h + B_t^f = 0.$$

It is affected by the mutual trade openness of the union members, since (α, γ) affects bonds accumulation,

$$B_{t+1}^h - B_t^h = (R_t - 1) B_t^h + \alpha (P_t^f C_t^f - P_t^h C_t^h) + \gamma (MC_t^f Y_t^f DP_t^f - MC_t^h Y_t^h DP_t^h).$$

1.4 Monetary Policy

The central bank of the monetary union controls the interest rate at its natural level,

$$R_t = \tilde{R}_t,$$

where \tilde{R}_t is the natural rate that corresponds to the pareto-optimal situation with flexible prices and complete assets market, such that $\eta^h = \eta^f = \pi_t^h = \pi_t^f = \chi = 0$.

2 An Estimated Loglinear Framework

This section solves the model in logdeviation and provides an estimation of the model parameters using EMU data.

2.1 The Model in Logdeviation

We assume that $A^i = A = 1$ and that $\tau = (1 - \theta)^{-1}$ to replicate the competitive flexible price steady state. The symmetric competitive flexible price steady state that insures the equilibrium of the union members current account is characterized by, $Y = (1 - \kappa)^{-\frac{\rho}{\psi+\rho}}$, $C = (1 - \kappa)^{\frac{\psi}{\psi+\rho}}$, $G = \kappa(1 - \kappa)^{-\frac{\rho}{\psi+\rho}}$, $N = (1 - \kappa)^{-\frac{\rho}{\psi+\rho}}$, $\frac{W}{P} = 1$ and $R = \beta^{-1}$.

The structural relations of the model in log deviation are presented in Table 1.

[Insert Table 1 here]

Furthermore, imposing $\eta^h = \eta^f = \pi_t^h = \pi_t^f = \chi = 0$, we define the natural adjustment of the monetary union following technology and fiscal shocks in Table 2. These values will be useful to define a benchmark that measures the welfare losses incurred by the imperfect integration of markets in the monetary union.

[Insert Table 2 here]

2.2 Estimation of the Model

The parameters are estimated on European data taken from the OECD Economic Outlook quarterly database, from 1970Q01 à 2004Q04. Aggregates are converted in the same currency and we focus on the following seasonally adjusted series: GDP (volume), private consumption (volume), GDP deflator, current account balance (relative to GDP), employment and real wages. Since the data for Austria, Luxembourg and Greece are incomplete, we do not take these countries into account in our estimation.

First, according to Benigno (2004) and Álvarez *et al.* (2006), we split EMU members in two groups, depending on their levels of nominal rigidities. Table 3 indicates the percentage of goods prices in the consumer price index changing every month in EMU countries. Setting the limit at 15%, the EMU divides in two groups of high and low nominal rigidities. In the first group (country h in the model), we have Germany, Spain and Italy. In the second group (country f in the model), we have all remaining countries. Although they account respectively for 57.8% and for 42.2% percent of EMU GDP, we assume that each group represents half of EMU's GDP.

[Insert Table 3 here]

Having defined the two "countries" of the monetary union, we build aggregated series given the relative weight of countries (variable in the time). We build inflation rates in each part of the euro zone using GDP deflator indices. We calculate series for real wages by subtracting nominal wage series and GDP deflators. We correct for the German reunification (as Germany has a sizable impact on both part of the Eurozone).⁶ Finally, all series are HP-filtred to make them stationary. We then compute the corresponding variance-covariance matrix before selecting interest second order moments that our model should be able to account for.

We estimate the parameters of the model by using the Simulated Method of Moments (SMM) of Hansen (1982).⁷ We estimate all parameters in the model, except β , which determines the real interest rate at the steady state and θ , that does not affect the dynamics of the model.⁸ We set $\beta = 0.988$, which corresponds to an annual real interest rate of 4.7%, consistent with the average real interest rate over the corresponding period in the EMU. Following Rotemberg and Woodford (1997), we impose $\theta = 7$.

Parameter estimates are reported in Table 4. The J-stat is 84% (with a 0.7561% p-value), so that the model is well specified and globally not rejected. Most of the parameters are significative. The signification of γ, κ and χ is not reported but ranges from 43% to 81%, which remains acceptable.

[Insert Table 4 here]

Parameter values are consistent with most estimates or calibrations reported in the literature. $\psi = 4.9132$ is on the lower bound of the range put forth by Canzoneri, Cumby and Diba (2006), $\rho = 1.1415$ is close to standard values (see Benigno, 2004). Parameters $\gamma = 0.0573$ and $\alpha = 0.2734$ determine the openness of intermediate and final goods markets. Estimated values are consistent with those found in Faia (2001) or with standard openness measures. $\kappa = 0.1713$ feature the steady state share of public spending in the GDP. The estimation of $\chi = 0.0008$ is very close to Schmitt-Grohé and Uribe (2003). Our estimation indicates that $\eta^h = 0.6417$ and $\eta^f = 0.4955$. These values match the values put forth in Alvarez *et alii.* (2006). Moreover, they confirm that the first group of countries features higher nominal

⁶This exogenous process can not be explained by the model. We thus consider the growth rate of raw series and replace any growth rate superior to 3% or inferior to -3% by the average growth rate of observation $t - 2$, $t - 1$, $t + 1$ and $t + 2$. Series are then rebuilt in level, logged and HP-filtered.

⁷See appendix B. A more complete description of the method can be found in Karamé, Patureau and Sopraseuth (2003).

⁸The elasticity of substitution within a subset of goods, θ , only affects inflation variance.

rigidities. Finally $\rho_a = 0.9788$, $\rho_g = 0.9832$, $std(\zeta_{a,t}^h) = 1.36\%$, $std(\zeta_{a,t}^f) = 0.98\%$, $\sigma(\zeta_{g,t}^h) = 0.92\%$ and $\sigma(\zeta_{g,t}^f) = 0.96\%$. These values are consistent with most values found in the RBC literature (see Backus, Kehoe and Kydland, 1992; Baxter, 1995; Chari, Kehoe and McGrattan, 2002).

3 The Potential Gains of Trade Integration with an Incomplete Financial Market

We define two complementary indicators to measure the potential welfare gains of trade integration in the EMU. The first indicator measures the quality of consumption pooling between union members. The second indicator computes the permanent consumption loss of a representative average consumer of the monetary union related to the imperfect integration of goods and financial market with respect to the pareto-optimal situation defined in Table 4.

3.1 Welfare Indicators

First, the quality of wealth risk-sharing in the monetary union is defined with regards to the cumulative deviation of relative wealths from the one that corresponds to complete wealth risk-sharing. This measure was initially proposed by Mundell (1973) and has been implemented in a NOEM framework by Devereux and Engel (2005). It is defined according to,

$$\Gamma_T = \sum_{s=t}^{s=T} \beta^{s-t} E_t \left\{ \left[\rho \left[c_s^f - c_s^h \right] + \left[p_s^f - p_s^h \right] \right]^2 \right\}^{\frac{1}{2}}. \quad (3)$$

In the case of complete financial markets, agents wealths are fully protected against asymmetric shocks and relative consumptions are fully determined through the adjustment of the real exchange rate (*i.e.* $\Gamma_T = 0$). In such a situation, the current account plays no role in the external adjustment. A positive value of Γ_T measures the inefficient relative consumption fluctuation coming from the incompleteness of the financial market in the monetary union.

Second, we compute the consumption equivalent welfare loss. Following Beetsma and Jensen (2005), Ψ_T is defined according to,

$$\Psi_T = 100 \cdot \left[\frac{(1 - \beta)}{[(1 - \kappa)(\rho + \psi(1 - \kappa))]} [\omega_{ref} - \omega_T] \right]^{\frac{1}{2}}, \quad (4)$$

where ω_{ref} measures the welfare at a given reference situation. Ψ_T converts the welfare loss associated to a pareto-inferior equilibrium of the economy into a sizable yardstick in terms of the permanent risk-adjusted consumption loss for an unchanged work effort. This indicator can be used to compare alternative economic situation in terms of their impact on welfare losses. For example, it is possible to measure potential welfare gains related to a better trade integration. To do this, the reference situation is the situation of perfect integration on goods and financial markets, *i.e.*, $\alpha = \gamma = \frac{1}{2}$ and $\chi = 0$. In this case, Ψ_T measures the reduction in welfare losses related to a perfect integration. In Eq. (4),

$$\omega_T = -\frac{q}{2} \sum_{s=t}^{s=T} \beta^{s-t} E_t \left\{ \frac{\theta}{2k^h} \pi_{H,s}^2 + \frac{\theta}{2k^f} \pi_{F,s}^2 + [\rho + \psi(1 - \kappa)] [\hat{y}_s^u]^2 \right. \\ \left. + (1 - \kappa) \varsigma_\alpha [\hat{s}_s]^2 + \varsigma_\gamma [\hat{\sigma}_s]^2 + \rho(1 - \kappa) [\hat{c}_s^r]^2 + \psi [\hat{n}_s^r]^2 \right\} + t.i.p + O(\|\xi^3\|),$$

where a hat on a variable denotes the deviation of this variable from its flexible prices complete assets markets equilibrium value given by table (4) (*e.g.* $\hat{s}_t = s_t - \tilde{s}_t$). Furthermore, $k^i = \frac{(1-\eta^i\beta)(1-\eta^i)}{\eta^i}$, $q = (1 - \kappa) \frac{\rho(1-\psi)}{\psi+\rho}$, *t.i.p* gathers terms independent of the problem and $O(\|\xi^3\|)$ terms of order 3 or higher.⁹ ω_T measures the welfare loss of price rigidities and financial markets incompleteness in the monetary union. The structure of ω_T makes the contribution of macroeconomic asymmetries more explicit on the inefficient allocation of resources in the monetary union. Indeed, ω_T takes into account the actualized national inflation ($\pi_{H,t}^2, \pi_{F,t}^2$) and aggregate output gap (\hat{y}_t^u), but also the allocation of resources within the union through the presence of the relative consumption gap (\hat{c}_t^r), the relative effort gap (\hat{n}_t^r), as well as the terms of trade gap ($\hat{s}_t, \hat{\sigma}_t$). One shall note that the weights affected to national inflation rates are sensitive to the degree of price stickiness through the values of k^i . Parameter k^i depends negatively on the degree of price rigidities, so that higher weights are deferred to inflation rates when prices are stickier.

3.2 Contrasting Channels of Trade Integration

Table 4 reports both welfare indicators (4) and (3), for the benchmark parametrization of the model summarized in Table 4. For each simulation, we plug a domestic and foreign asymmetric random productivity and public spending innovation at each period. Running 20 simulations for $T = 120$ quarters, we report the average values of both indicators with respect to two reference situations.

⁹See appendix B for detailed computations of the welfare based loss function.

[Insert Table 5 here]

The first part of Table 5 reports the maximum welfare gain that can be obtained in the monetary union following a complete integration of the goods and financial markets (*i.e.*, $\alpha = \gamma = \frac{1}{2}$ and $\chi = 0$). In the best situation, the welfare gain amounts to an equivalent doubling of permanent consumption (*i.e.*, an increase of $\Psi_T = 100.39\%$). One shall note that the size of this potential gain must be balanced by the fact that it may take a very long time, if ever, to reach this situation. Furthermore, this result is sensitive to the value of ψ . As shown in Table 5, a rise of this parameter from $\psi = 4.9$ to $\psi = 15$ reduces the consumption equivalent welfare loss associated to segmented goods markets, since the potential gains that can be reached amounts to 70% of the initial value. This drop in the initial inefficiency is explained as follows: since ψ affects the Frischian elasticity, higher values of ψ translate into a lower volatility of working efforts, and thereby of output gaps and inflation rates. As these variables enter the welfare loss function, a higher value of ψ lowers the potential gains (or losses) of a better integration on each market.

The value of the distance risk-sharing ($\Gamma_T = 53.898$) with respect to the complete market situation serves as a benchmark to assess how goods market integration improves risk-sharing in the monetary union. This value is very sensitive to risk aversion. A rise of this parameter from $\rho = 1.14$ to $\rho = 5$ increases the distance from $\Gamma_T = 53.89$ to $\Gamma_T = 93.58$. Indeed, as agents become more risk adverse, they are more affected by the suboptimal consumption risk-sharing pattern implied by the incomplete integration of the goods market given price stickiness.

The second part of Table 5 investigates the welfare effects of a 1% increase in final and intermediate trade integration and in financial integration. We find that trade integration of intermediate and final goods are not substitutes. Indeed, we show that an increase of the mutual trade in final goods has a large impact on consumption pooling but deteriorates the intertemporal allocation of resources. Inversely, an increase of the mutual trade in intermediate goods is highly welfare improving but has only a limited impact on risk-sharing. In the next paragraphs, we detail these results and highlight the key role of financial adjustments when trade integration is deeper.

First, an increase in the mutual trade of final goods reduces wealths dispersion in the monetary union. The distance of consumption risk-sharing is reduced by 1.2% for a 1% reduction in the home bias. An increase in α makes aggregate consumptions and consumption price

indexes more homogenous among nations and reinforces the role of the current account as an instrument to smooth consumption when financial markets are incomplete in the case of asymmetric shocks. For the same reason, the greater use of the current account leads to a greater disconnection of output levels between countries in the long run. Indeed, to meet the transversality condition, the economy running a current account deficit (surplus) will have to produce more (less) in the long run to finance the initial imbalance. This, in turn, disconnects business cycles in the monetary union and induces welfare losses, equivalent to a 2.00% drop in permanent consumption.

Regarding this key result of the paper, one shall also remark that, for a given value of α , a lower value of χ increases the welfare loss. Indeed, the reduction of portfolio costs increases the use of the current account, which reinforces the welfare loss depicted above. In the same way, an increase in ρ deteriorates welfare in the monetary union. *Ceteris paribus*, an increase in risk aversion makes agents more keen on pooling the effects of asymmetric shock by a greater use of the current account, which reinforces the negative long run impact on resources allocation in the union, for a given level of price stickiness.

In contrast, a greater integration of the intermediate goods market leads to more standard results. The increase in vertical trade makes production processes more homogeneous, induces more symmetry in the diffusion of asymmetric shocks and contributes to the stability of the terms of trade which impacts the loss function (4). In the baseline calibration, a 1% reduction in the value of γ reduces relative wealths variability by 0.21%. This value is quite lower than the one obtained above for the final goods market, since agents use less the current account to smooth the consequences of less asymmetric shocks. As a consequence, output fluctuations are less asymmetric to meet the current account equilibrium in the long run. This however leads to a sizeable improvement of the intertemporal allocation of resources in the monetary union, that accounts for an equivalent permanent consumption increase of 7.52%.

Finally, Table 6 shows that the convergence of nominal rigidities - given a constant average level of price stickiness in the monetary union - can at best lead to a 10% reduction of inefficiency in the monetary union.¹⁰ By correcting an inefficiency in the terms of trade adjustment between union members, the reduction of the dispersion of inflation rates makes the actual equilibrium closer to the natural equilibrium. Nevertheless, all the results obtained under

¹⁰ Calibrations for simulations in the case of homogeneous nominal rigidities nests on Benigno (2004). The average level of nominal rigidities is calculated through the average contract duration, *i.e.* $(1 - \bar{\eta})^{-1} = (1 - \eta^h)^{-1/2} (1 - \eta^f)^{-1/2} \Rightarrow \bar{\eta} = 0.5748$.

the initial calibration are preserved, although at a lower value, since the initial equilibrium is closer to the natural equilibrium.

[Insert Table 6 here]

4 Conclusion

The aim of this paper was to evaluate the potential gains associated to the deeper integration of the goods market observed in Europe since the adoption of the Euro. Building on a New Open Economy Macroeconomics model of an asymmetric monetary union, we have contrasted the consequences of the increase in the mutual trade of intermediate and final goods.

Simulating our model over European data we have shown that the potential welfare gains could imply up to a doubling of permanent consumption. We have more particularly underlined the optimality of a greater integration of the intermediate goods market. We have also shown that the reduction of asymmetries in nominal rigidities has a marginal effect on our results. In contrast, the increase in horizontal trade may induce some welfare losses, since national intertemporal constraints may imply an inefficient long run production disconnection between union members given short run price rigidity.

References

- Backus, D. K., Kehoe, P. J. & Kydland, F. E. (1992), ‘International Real Business Cycles’, *Journal of Political Economy* **100**, 745–75.
- Baxter, M. (1995), International Trade and Business Cycles, *in* G. Grossman & K. Rogoff, eds, ‘Handbook of International Economics’, Vol. III, Elsevier Science B.V., chapter 35, pp. 1801–64.
- Beetsma, R. M. W. J. & Jensen, H. (2005), ‘Monetary and Fiscal Policy in a Micro-founded Model of Monetary Union’, *Journal of International Economics* **67**(2), 320–52.
- Benigno, P. (2004), ‘Optimal Monetary Policy in a Currency Area’, *Journal of International Economics* **63**(2), 293–320.
- Benigno, P. & Woodford, M. (2005), ‘Inflation Stabilization and Welfare: The Case of a Distorted Steady State’, *Journal of the European Economic Association* **3**(6), 1185–1236.
- Calvo, G. (1983), ‘Staggered Prices in a Utility-maximizing Framework’, *Journal of Monetary Economics* **12**(3), 383–98.
- Canzoneri, M. B., Cumby, R. E. & Diba, B. T. (2006), ‘The Cost of Nominal Inertia in NNS Models’, *Journal of Money, Credit and Banking* . Forthcoming.
- Chari, V. V., Kehoe, P. J. & McGrattan, E. R. (2002), ‘Can Sticky Price Models Generate Volatile and Persistent Real Exchange Rates’, *Review of Economic Studies* **69**(3), 533–63.
- Corsetti, G. (2006), ‘Openness and the Case for Flexible Exchange Rates’, *Research in Economics* **60**(1), 1–21.
- Devereux, M. B. & Engel, C. (2006), ‘Expenditure Switching vs. Real Exchange Rate Stabilization: Competing Objectives for Exchange Rate Policy’, *Journal of Monetary Economics* . Forthcoming.
- Faia, E. (2006), ‘Finance and International Business Cycles’, *Journal of Monetary Economics* . Forthcoming.
- Gourieroux, C., Montfort, O. & Renault, E. (1993), ‘Indirect Inference’, *Journal of Applied Econometrics* **8**, S85–S118.

- Hansen, L. P. (1982), ‘Large Sample Properties of Generalized Method of Moments Estimators’, *Econometrica* **50**, 1029–54.
- Ingram, B. F. & Lee, B. S. (1991), ‘Simulation Estimation of Time Series Models’, *Journal of Econometrics* **47**(2-3), 197–205.
- Karamé, F., Patureau, L. & Sopraseuth, T. (2003), Limited Participation and Exchange Rate Dynamics : Does Theory Meet the Data ?, Cahiers de la Maison des Sciences Economiques v04013, Université Panthéon-Sorbonne (Paris 1).
- Mundell, R. A. (1973), Uncommon Arguments for Common Currencies, *in* H. G. Johnson & A. K. Swoboda, eds, ‘The Economics of Common Currencies’, Allen and Unwin, pp. 114–32.
- Obstfeld, M. & Rogoff, K. (2000), The Six Major Puzzles in International Macroeconomics: Is there a Common Cause?, *in* B. Bernanke & K. Rogoff, eds, ‘NBER Macroeconomics manual 2000’.
- Rotemberg, J. J. & Woodford, M. (1997), An Optimization-based Econometric Framework for the Evaluation of Monetary Policy, *in* B. Bernanke & J. J. Rotemberg, eds, ‘NBER Macroeconomics Annual’, pp. 297–346.
- Schmitt-Grohé, S. & Uribe, M. (2003), ‘Closing small open economy models’, *Journal of International Economics* **61**(1), 163–85.
- Woodford, M. (2003), *Interest and Price*, Princeton University Press.

Table 1: Linear Version of the Model

Households conditions	
$\rho E_t [c_{t+1}^i - c_t^i] = \frac{\delta}{1+\delta} r_{t+1} - E_t [\pi_{t+1}^i] - \chi (1 - \kappa)^{\frac{\psi}{\psi+\sigma}} b_{t+1}^i, i \in \{h, f\}$	
$\psi n_t^i + \sigma c_t^i = w_t^i - p_t^i, i \in \{h, f\}$	
Prices, inflation and costs	
$\pi_{i,t} = \beta E_t [\pi_{i,t+1}] + \frac{(1-\eta^i\beta)(1-\eta^i)}{\eta^i} (mc_t^i - p_{i,t}), i \in \{h, f\}$	
$mc_t^h = (1 - \gamma) (w_t^h - a_t^h) + \gamma (w_t^f - a_t^f)$	
$mc_t^f = (1 - \gamma) (w_t^f - a_t^f) + \gamma (w_t^h - a_t^h)$	
$s_t = p_{F,t} - p_{H,t} \quad \sigma_t = w_t^f - w_t^h + a_t^h - a_t^f$	
Market clearing	
$y_t^h = (1 - \kappa) [(1 - \alpha) c_t^h + \alpha c_t^f + 2\alpha (1 - \alpha) s_t] + \kappa g_t^h, \text{ with } g_{t+1}^h = (1 - \epsilon_g) g_t^h + \zeta_{g,t+1}^h$	
$y_t^f = (1 - \kappa) [(1 - \alpha) c_t^f + \alpha c_t^h - 2\alpha (1 - \alpha) s_t] + \kappa g_t^f, \text{ with } g_{t+1}^f = (1 - \epsilon_g) g_t^f + \zeta_{g,t+1}^f$	
$a_t^h + n_t^h = (1 - \gamma) y_t^h + \gamma y_t^f + 2\gamma (1 - \gamma) \sigma_t, \text{ with } a_{t+1}^h = (1 - \epsilon_a) a_t^h + \zeta_{a,t+1}^h$	
$a_t^f + n_t^f = (1 - \gamma) y_t^f + \gamma y_t^h - 2\gamma (1 - \gamma) \sigma_t, \text{ with } a_{t+1}^f = (1 - \epsilon_a) a_t^f + \zeta_{a,t+1}^f$	
Current account	
$b_{t+1}^h - b_t^h = \delta b_t^h + \alpha [(p_t^f + c_t^f) - (p_t^h + c_t^h)] + \frac{\gamma}{1-\chi} [(mc_t^f + y_t^f) - (mc_t^h + y_t^h)]$	
$b_s^f = -b_s^h, \forall s$	

Table 2: Natural equilibrium of the model

$\tilde{r}_{t+1} = \frac{\rho(1+\delta)\kappa\psi(1-\epsilon_g)}{\delta(\psi(1-\kappa)+\rho)} g_t^u - \frac{\rho(1+\delta)(\psi+1)(1-\epsilon_a)}{\delta(\psi(1-\kappa)+\rho)} a_t^u$	$\tilde{y}_t^u = \frac{(1-\kappa)(\psi+1)}{\psi(1-\kappa)+\rho} a_t^u + \frac{\kappa\rho}{\psi(1-\kappa)+\rho} g_t^u$
$\tilde{\sigma}_t = \frac{2\kappa\psi(1-2\gamma)}{\varpi_\gamma} g_t^r - \frac{2(1+\psi)}{\varpi_\gamma} a_t^r$	$\tilde{s}_t = \frac{2\kappa\psi(1-2\gamma)^2}{\varpi_\gamma} g_t^r - \frac{2(1+\psi)(1-2\gamma)}{\varpi_\gamma} a_t^r$
$\tilde{c}_t^r = \frac{2(1+\psi)(1-2\gamma)(1-2\alpha)}{2\rho\varpi_\gamma} a_t^r - \frac{2\kappa\psi(1-2\gamma)^2(1-2\alpha)}{2\rho\varpi_\gamma} g_t^r$	$\tilde{n}_t^r = \frac{2(\varpi_\alpha(1-2\gamma)^2+2\varsigma_\gamma)-1}{\varpi_\gamma} a_t^r + \frac{\kappa(1-2\gamma)}{\varpi_\gamma} g_t^r$
with,	
$x_t^u = \frac{1}{2}x_t^h + \frac{1}{2}x_t^f, \quad \forall x, \forall t$	$x_t^r = \frac{1}{2}x_t^f - \frac{1}{2}x_t^h, \quad \forall x, \forall t$
$\varpi_\alpha = \frac{(1-\kappa)((1-2\alpha)^2+4\rho\varsigma_\alpha)}{2\rho}$	$\varpi_\gamma = 1 + 2\psi(\varpi_\alpha(1-2\gamma)^2 + 2\varsigma_\gamma)$
$\varsigma_\gamma = \gamma(1-\gamma)$	$\varsigma_\alpha = \alpha(1-\alpha)$

Table 3: Nominal rigidities and country weights in the EMU

	Region	% goods in the CPI changing prices every month	% of country's GDP in the EMU GDP
Germany	<i>h</i>	13.5	29.1
France	<i>f</i>	23.9	21.6
Italy	<i>h</i>	10.0	17.7
Spain	<i>h</i>	13.3	11.0
Netherlands	<i>f</i>	16.2	6.4
Belgium	<i>f</i>	17.6	3.7
Luxembourg	<i>f</i>	23.0	–
Austria	<i>f</i>	15.4	3.1
Finland	<i>f</i>	20.3	2.0
Portugal	<i>f</i>	21.1	1.8
Ireland	<i>f</i>	–	2.0
Greece	<i>f</i>	–	2.2

Table 4: Parameters estimations and t-statistics

ψ	4.9132*** (3.7572)	κ	0.1743 (0.6293)	ϵ_a	0.9788*** (5.0930)	$\sigma(\zeta_{g,t}^h)$	0.0092*** (4.1964)
ρ	1.1415*** (2.7383)	η^h	0.6417*** (2.6021)	ϵ_g	0.9832*** (6.1566)	$\sigma(\zeta_{g,t}^f)$	0.0096*** (3.4174)
α	0.2734*** (3.9109)	η^f	0.4955*** (2.7511)	$\sigma(\zeta_{a,t}^h)$	0.0136*** (3.6820)		
γ	0.0573 (1.3124)	χ	0.0008 (0.5613)	$\sigma(\zeta_{a,t}^f)$	0.0098*** (6.2923)		
		<i>J – stat</i>			19.674		
		$\Psi(\hat{\varphi}_T^*)$			$\chi^2(27)$		
		<i>p – value</i>			0.8441		

* * *: 99% significant

Table 5: Welfare analysis - Asymmetric nominal rigidities

The welfare costs of imperfect integration in the EMU					
	<i>BC</i>	$\rho = 2$	$\rho = 5$	$\psi = 10$	$\psi = 15$
Welfare index (%)	100.39	98.89	90.61	81.94	71.14
Distance to risk-sharing	53.89	64.81	93.57	55.93	56.75
The welfare gains of trade and financial integration in the EMU					
	<i>BC</i>	$\rho = 2$	$\rho = 5$	$\psi = 10$	$\psi = 15$
Welfare index (%)					
$\alpha = 1.01 \cdot \alpha_{BC}$	-2.00	-2.77	-3.22	-1.22	-1.22
$\gamma = 1.01 \cdot \gamma_{BC}$	7.51	7.30	6.51	6.57	5.88
$\chi = 1.01^{-1} \cdot \chi_{BC}$	-0.49	-0.99	-1.15	-0.37	-0.31
Reduction of the distance to risk-sharing (%)					
$\alpha = 1.01 \cdot \alpha_{BC}$	1.21	1.19	1.05	1.22	1.22
$\gamma = 1.01 \cdot \gamma_{BC}$	0.21	0.21	0.18	0.22	0.23
$\chi = 1.01^{-1} \cdot \chi_{BC}$	0.00	0.01	0.03	0.00	0.00

BC: Baseline calibration**Table 6: Welfare analysis - Symmetric nominal rigidities**

The welfare costs of imperfect integration in the EMU					
	<i>BC</i>	$\rho = 2$	$\rho = 5$	$\psi = 10$	$\psi = 15$
Welfare index (%)	90.83	86.99	76.19	72.55	62.24
Distance to risk-sharing	54.72	66.14	95.70	56.64	57.39
The welfare gains of trade and financial integration in the EMU					
	<i>BC</i>	$\rho = 2$	$\rho = 5$	$\psi = 10$	$\psi = 15$
Welfare index (%)					
$\alpha = 1.01 \cdot \alpha_{BC}$	-1.96	-2.52	-2.68	-1.40	-1.15
$\gamma = 1.01 \cdot \gamma_{BC}$	7.04	6.72	5.81	6.04	5.34
$\chi = 1.01^{-1} \cdot \chi_{BC}$	-0.47	-0.94	-1.07	-0.35	-0.30
Reduction of the distance to risk-sharing (%)					
$\alpha = 1.01 \cdot \alpha_{BC}$	1.21	1.19	1.05	1.22	1.22
$\gamma = 1.01 \cdot \gamma_{BC}$	0.21	0.20	0.18	0.22	0.23
$\chi = 1.01^{-1} \cdot \chi_{BC}$	0.00	0.01	0.03	0.00	0.00

BC: Baseline calibration