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by Marcelo Sánchez

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by Marcelo Sánchez[2]

In 2009 all ECB publications feature a motif taken from the €200 banknote.

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Abstract

Existing work on wage bargaining (as exemplified by Cukierman and Lippi, 2001) typically predicts more aggressive wage setting under monetary union. This insight has not been confirmed by the EMU experience, which has been characterised by wage moderation, thereby eliciting criticism from Posen and Gould (2006). The present paper formulates a model where, realistically, trade unions set wages with national prices in mind, deviating from Cukierman and Lippi (2001) who postulate that wages are set having area-wide prices in mind. For reasonable ranges of parameter values (and macroeconomic shocks), simulations show that a monetary union is found to elicit real wages that are broadly comparable to those obtained under monetary autonomy. The confidence bounds around these results are rather wide, in particular including scenarios of wage restraint. The paper also performs welfare comparisons concerning macroeconomic stabilisation in light of structural factors such as country size, the preference for price stability, aggregate demand slopes, labour substitutability across unions, the number of wage-setting institutions and the cross-country distribution of technology and demand shocks.

JEL classification: E50, E58, J50, J51

Keywords: Inflation, Trade Unions, Monetary Union, Strategic Monetary Policy, Unemployment, Wage Moderation

Non-technical summary

Existing work on wage bargaining typically predicts more aggressive wage setting under monetary union. This insight has not been confirmed by the EMU experience, which has been characterised by wage moderation, thereby eliciting criticism from Posen and Gould (2006). The present paper formulates a model which, realistically, postulates that trade unions care about national prices when setting wages. We thus deviate from Cukierman and Lippi (2001) who model unions as setting wages with area-wide prices in mind. Our assumption that unions care about national prices when setting wages brings into the analysis the output side of the economy. In particular, we allow for a varying wage share on the supply side, while also allowing for interest rate sensitiveness of real demand. Our main finding is that, contrary to Cukierman and Lippi (2001), results from our extended model are parameter-dependent, thus failing to establish as a general conclusion that monetary union triggers aggressive wage demands.

We follow two main approaches. First, we derive analytical results using a deterministic model under the two special cases considered by Cukierman and Lippi (2001), namely, identical countries and the absence of inflation aversion on the part of trade unions. This setup is also illustrated by means of baseline parameter values. In contrast with Cukierman and Lippi (2001), we find that the question whether monetary union alters real wages compared with those obtained under monetary autonomy does not have an unambiguous affirmative answer. That is, the actual answer turns out to depend on specific values assigned to the model parameters. We have thoroughly examined the likelihood of wage restraint in a case where we allow for some degree of heterogeneity across member countries. The odds in favour of wage restraint appear to be non-negligible, in contrast with the findings in CL. This result is obtained from deterministic simulations, which in particular suggest that the

probability of a wage restraint scenario is rather likely under our baseline parameterisation. Second, we draw on the full range of plausible parameter values under both deterministic and stochastic setups. We find that median macro developments are found not to be much altered by monetary union, while mean developments point to monetary union delivering extra wage moderation, lower levels of inflation, unemployment and wage share, and higher activity levels. Unlike Cukierman and Lippi's (2001), our results are thus not at odds with the evidence of wage restraint often reported since the launch of the euro in 1999. In obtaining our results, we do not resort to effects stemming from globalisation or enhanced monetary policy credibility (Posen and Gould, 2006). It is worth saying that our simulation analysis points to considerable variability surrounding baseline simulation results, depending on parameter (and shock) values drawn. This finding points to caution when using the general class of models to which the one used here belongs.

Finally, our study of monetary stabilisation in a currency union includes welfare comparisons in the face of technology and demand shocks. We show that the main results depend on the distribution of shocks across the union, as well as on key structural parameters. In particular, the aggregate demand slope, labour substitutability across unions, and the number of wage-setting institutions are allowed to be country-specific, with the monetary policy response depending on all these sources of structural heterogeneity.

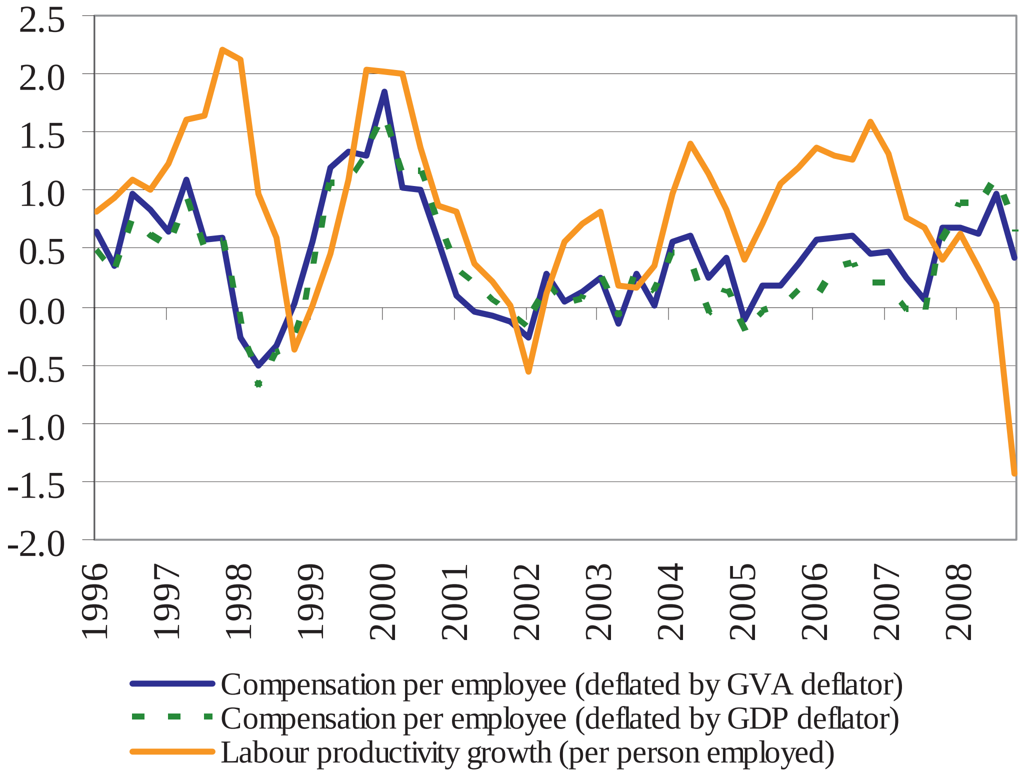
1. Introduction

The experience and prospects of monetary integration around the world have attracted a wide-ranging literature over the last fifty years. Some analyses have addressed the role of the interaction between monetary policy and wage-setting institutions. In their oft-cited study, Cukierman and Lippi (2001; henceforth CL) show that, with unionised labour markets, monetary union entails higher real wages than in a national monetary policy setup. CL is the workhorse model for the strategic interaction between (free-riding) wage-setters and the ECB. It is an appealing framework in that it models a number of trade unions within each of two countries, and it shows that a monetary arrangement (EMU) can have effects not only on nominal but real variables. CL derive implications for some key macro variables: inflation, nominal and real wages, unemployment.

CL's result that monetary union entails higher real wages than in the national case has been challenged by Posen and Gould (2006) in light of the evidence for the period since the euro area was created in 1999. In particular, these authors report that real wage growth appears to have fallen short of productivity growth (be it per hour worked or in multi-factor terms) in the post-EMU period.[1] Chart A below presents evidence that real compensation per employee has been moderate since 1996, including when compared with labour productivity per person employed. Although the latter has decelerated markedly over the last year or so, this has happened in the context of unprecedented financial conditions and its timing – a decade after

[1] Posen and Gould's (2006) look more generally at the evidence of wage restraint (as measured by the contained gap between real wage and productivity developments) across OECD countries. They mention that, excluding Greece, some other countries (including from the euro area) would exhibit a significant gap between productivity growth measures and real wage growth.

Chart A. Euro area labour compensation and labour productivity, 1996-2008



Source: Eurostat.

the launch of the euro – clearly suggests that this development is unrelated to the single monetary policy itself. Table 1 reports available data for the wage share in total euro area income. Adopting a longer-run standpoint, it is not possible to ascertain whether the underlying trend in the wage share has shifted one way or another since the late 1990s. Moreover, the fall in the wage share that has been registered over time appears not to be purely the result of a reallocation of output towards sectors where the wage share is lower.

CL assume that trade unions care about area-wide price developments when setting wages – an assumption also maintained elsewhere (Cukierman, 2004). The aim of the present paper is to extend the literature by studying whether it matters that trade unions still care about national prices in a monetary union.[2] Supply-side free-riding problems of the type examined

[2] For the euro area, see e.g. CESifo (2007), European Commission (2007) and OECD (2005).

here arguably raise different short-run stabilisation issues compared to the fiscal free-riding operating on the demand side (Sánchez, 2008b).

In this paper we first present the general set up, which allows for shocks to both productivity and real demand. We distinguish between two monetary arrangements, namely, national monetary policy and a currency union. We then turn to the determinist case, studying the two main cases studied by CL, namely, a monetary union between identical countries and a monetary union between heterogeneous countries that do not care about inflation. Finally, we look at the general stochastic model from the angle of welfare comparisons between currency union participation and the alternative of autonomous monetary policy. The latter allow us to assess monetary stabilisation properties of a currency union, highlighting the role of structural parameters and the type and cross-country distribution of shocks. Quantitative comparisons of stabilisation performance of the type performed here are meant to complement the previously mentioned analytical results obtained in a deterministic environment.

Sections 2 and 3 of this paper lay out the models for the analysis of autonomous monetary policy and a currency union, respectively. Section 4 focuses on the effect of currency union on real wages compared with the national case. Section 5 describes the general simulation results allowing for all types of country-specificities concerning shocks and parameter values. Section 6 reports quantitative results on monetary union stabilisation performance relative to monetary autonomy as well as the corresponding sensitivity analysis. Finally, section 7 presents our main conclusions.

2. The case of national monetary policy

We start by studying the case when a given country i (i = 1,2)[3] pursues national monetary policy. Country i comprises N_i labour unions (indexed by j). The preferences of a typical union are described by the loss function

$$\Omega_{ij} = -2w_{ij}^r + Au_{ij}^2 + B\pi_i^2 \qquad (1)$$

where w_{ij}^r, u_{ij} and π_i are, respectively, the (log of the) real wage, the unemployment rate among members of union j in country i, and the inflation rate. In addition, monetary policy is conducted by a central bank who dislikes variability in both inflation and output (y_i) at home:

$$\Gamma_i = y_i^{\,2} + \chi\pi_i^{\,2} \qquad (2)$$

where χ is the central bank weight on inflation aversion relative to output stabilisation.

We postulate that goods markets are imperfectly competitive, with firms setting prices as a mark-up over marginal cost. All firms are assumed to employ CES production function (in levels) $Y_i = \left[\tau(K_i)^{\frac{\sigma-1}{\sigma}} + (1-\tau)(X_i L_i)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$, where X_i is the level of labour-augmenting technology, τ a distribution parameter between 0 and 1, and σ the elasticity of substitution between capital (K_i) and labour (L_i).[4] We assume that K_i remains constant throughout the analysis. Denote by w_{ij}^r the (log of the) real wage corresponding to union j in country i, which is defined as $w_{ij}^r \equiv w_{ij} - \pi_i$.[5] Moreover, let $\bar{w}_i^r$ be the country-level average of the (log

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[3] Moreover, we often characterise the two countries as being i and k.

[4] See e.g. Rowthorn (1999), and the applied work by Jalava et al. (2006), Klump et al. (2007a, 2007b), and Ripatti and Vilmunen (2001).

[5] Note that we normalise the previous-period price level to 1 (0 in logs).

of the) real wage,[6] $w_i^{rc} \equiv d_i - 1/\alpha$ be the (log of the) competitive real wage at which the national labour market clears in the absence of shocks (i.e. $\bar{u}_i = 0$ and $x_i = 0$), and $\Phi_{ij} \equiv w_{ij}^r - w_i^{rc}$ be the real wage premium (over the competitive real wage). Under the assumptions that goods markets are imperfectly competitive and labour is rewarded according to marginal productivity, firms' optimisation implies that output (in percentage deviations from the competitive, deterministic steady state) is $y_i = -\eta(\bar{w}_i^r - w_i^{rc} - x_i) = -\eta\left(\bar{\Phi}_i - x_i\right)$, where x_i is a technology shock, $\eta \equiv s_L \kappa\sigma/(\kappa - s_L)$, $\kappa \equiv 1 - 1/\lambda$ is the inverse of the price mark-up, λ is the price elasticity of demand faced by firms, and s_L is the (steady-state value of) the labour share, $\kappa(1-\tau)[Y_i/(X_i L_i)]^{\frac{1-\sigma}{\sigma}}$.[7]

Country i's labour supply is L_i. Labour is uniformly distributed over N_i unions and is supplied inelastically. The typical union faces the labour demand:

$$L_{ij}^d = \left[\frac{\alpha(1-x_i)}{N_i}\left(d_i - w_{ij}^r\right) - \gamma_i\left(w_{ij}^r - \bar{w}_i^r\right)\right]L_i \tag{3}$$

where γ_i is the degree of labour substitutability, $\alpha \equiv \kappa\sigma/(\kappa - s_L)$ is the elasticity of labour demand (with respect to the real wage) and d_i is a constant.[8] Equation (3) posits that when a

[6] National aggregates across trade unions are denoted by an upper bar; for instance, $\bar{w}_i^r \equiv \sum_{j=1}^{N_i} w_{ij}^r / N_i$.

[7] Assuming that in the deterministic case $X_i = 1$, then $x_i \cong X_i - 1$. In the following, we also think of x_i as being a small number in absolute terms; we thus use the approximations $x_i/(1+x_i) = x_i$, $1/(1+x_i) = 1 - x_i$, and $x_i/(1+x_i)^2 = 1 - 2x_i$.

[8] At the country level, the unemployment rate equals $\bar{u}_i = 1 - \left\{(1-x_i)\left[1 - \alpha\left(\bar{w}_i^r - w_i^{rc}\right)\right]\right\}$. Using the approximation that $\bar{\Phi}_i^N x_i = 0$, we can express this as $\bar{u}_i = x_i + \alpha\bar{\Phi}_i^N$.

union sets its real wage equal to the country average it obtains $1/N_i$ of aggregate labour demand. In light of (3), overall country-level labour demand equals $L_i^d = \alpha(1-x_i)\left(d - \bar{w}_i^r\right)$.

Moreover, from (3) the unemployment rate among union *j*'s members equals

$$u_{ij} \equiv \frac{L_i - L_{ij}^d}{L_i} = 1 - \left\{(1-x_i)\left[1-\alpha\left(w_{ij}^r - w_i^{rc}\right)\right] + \gamma_i N_i\left(w_{ij}^r - \bar{w}_i^r\right)\right\} \qquad (4)$$

Regarding real demand for output, we postulate the equation $y_i = -\beta_i\left(R_i - E[\pi_i]\right) + \mu_i$, which includes demand shock term μ_i. This can be justified in two ways. First, together with the output supply equation, our real demand schedule does not affect the monetary policy reaction function for a national central bank nor that obtained under monetary union (derived below). In particular, the reaction functions obtained here are the same as in CL, except for allowing for disturbances. Second, our real demand equation captures an intuitive, simple mechanism, given by a negative response of demand to the real interest rate. A similar specification for the real demand schedule, involving a conventional money demand function, has been used in Coricelli et al. (2004 and 2006). We follow CL in assuming rational expectations: $\pi_i = E[\pi_i]$.

Solving the model requires, first of all, some assumption concerning how information is disseminated among agents. We postulate that the shocks are known at the beginning of the game, that is, that the model is one of perfect information. Shocks are thus not meant to reflect information that is unknown to agents, but rather extra terms capturing factors not contained among the determinants explicitly accounted for in the simple model set up here. That is, they can be seen as capturing the role of factors normally monitored by agents when taking decisions, but that we neglect for simplicity. In order to distinguish between the case when we take into account the extra terms given by the shocks and that when we ignore them (i.e. when we set disturbances equal to zero), we resort to the concepts of "deterministic" and "stochastic" models (or simulations), respectively. We decide to employ this terminology, even if it should be clear that the "stochastic" analysis pursued here implies uncertainty only about the specific source of macroeconomic fluctuations, but not about the value of the shock realisations.

With regard to the timing of decisions, the present model consists of a two-stage game that we solve by backward induction, focusing on discretionary policy. In the second stage the central bank chooses the interest rate R to minimise (2) taking the nominal wages set by all unions as given. This yields

$$\pi_i = \theta\left(\bar{w}_i - w_i^{rc} - x_i\right) = \frac{\eta^2}{\chi}\left(\bar{\Phi}_i - x_i\right) \qquad \text{with } \theta \equiv \frac{\eta^2}{\eta^2 + \chi} \tag{5}$$

In the first stage unions choose their nominal wages simultaneously. Union j in country i chooses w_{ij} to minimise (1), taking the nominal wages of other unions and the reaction function (5) as given. This yields the equilibrium real wage premium[9]

$$\bar{\Phi}_i^N = \frac{Z_i^N + \left\{B\left(\eta^2/\chi\right)\left(1 - Z_i^N\right) - A\left[\alpha Z_i^N + \gamma_i\left(N_i - 1\right)\right]\right\}x_i}{\alpha A\left[\alpha Z_i^N + \gamma_i\left(N_i - 1\right)\right] + B\left(\eta^2/\chi\right)\left(1 - Z_i^N\right)} \tag{6}$$

where $Z_i^N \equiv 1 - d\pi_i / dw_{ij} = 1 - \theta / N_i$ measures the degree to which nominal wage increases (i.e. rises in w_{ij}) translate into gains in real earnings. In (6), a number of parameters enter the determination of the wage premium. It is worth noting that real-demand-side parameter β_i is however not one of those parameters; by not affecting the wage premium it also fails to influence domestic inflation, and the level of economic activity (as measured by either output or the unemployment rate), thus only impacting the determination of the interest rate.

[9] In deriving (6), we approximate $\bar{\Phi}_i^N x_i = 0$.

3. A currency union with trade unions caring about national prices

Here we consider a two-country model. Country *i* (*i* = 1,2) comprises N_i labour unions (indexed by *j*). In addition, a "single" monetary authority (SMA) conducts area-wide monetary policy. The preferences of a typical union are still described by loss function (1). Furthermore, the SMA dislikes variability in both inflation and output (y_i) at the currency union level:[10]

$$\Gamma_u = y_u^{\,2} + \chi \pi_u^{\,2} \tag{7}$$

Country *i*'s labour supply is L_i. Labour is uniformly distributed over N_i unions and is supplied inelastically. The typical union continues to face labour demand (3). The unemployment rate among union *j*'s members remains given by (4).

As in the case of national monetary policy, under the monetary union regime the real wage, w_{ij}^r, is defined in terms of domestic prices, that is, $w_{ij}^r \equiv w_{ij} - \pi_i$. By assuming this for the currency union arrangement we deviate from CL, who instead postulate that w_{ij}^r is defined in terms of area-wide prices, that is, $w_{ij}^r \equiv w_{ij} - \pi_u$.

We continue to assume rational expectations, and the country-level equations for the demand for and supply of output discussed in the previous section still hold. A two-stage game is solved by backward induction. In the second stage, the SMA chooses the interest rate *R* to minimise (7) taking the nominal wages set by all unions as given. This yields the reaction function

$$\pi_u = \theta\left(s_i \bar{w}_i + s_k \bar{w}_k - w_u^{rc} - x_u\right) = \frac{\eta^2}{\chi}\left(\Phi_u - x_u\right) \tag{8}$$

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[10] We denote with subindex *u* all area-wide aggregates. For simplicity, we use the same set of country weights, (s_i, s_k), for both labour and output market variables. Instead of output, CL include unemployment in the central bank's loss function.

In the first stage unions choose their nominal wages simultaneously. Union j in country i chooses w_{ij} to minimise (1), taking the nominal wages of other unions (both at home and abroad) and the reaction function (8) as given. This yields the country-level equilibrium real wage premium under regime D:[11]

$$\bar{\Phi}_i^D = \frac{Z_i^D - B\left(1-Z_i^D\right)\left(\eta^2/\chi+\eta/\beta_k\right)s_k\,\bar{\Phi}_k^D + B\left(1-Z_i^D\right)\Xi_i}{\alpha A\left[\alpha Z_i^D+\gamma_i\left(N_i-1\right)\right]+B\left(1-Z_i^D\right)\left[\left(\eta^2/\chi\right)s_i-\eta s_k/\beta_i\right]} \tag{9}$$

where $\Xi_i \equiv \left\{\eta\left(\eta s_i/\chi - s_k/\beta_i\right) - A\left[\alpha Z_i^D+\gamma_i\left(N_i-1\right)\right]/\left[B\left(1-Z_i^D\right)\right]\right\}x_i + \left(\eta^2/\chi+\eta/\beta_k\right)s_k x_k + \left(s_k/\beta_i\right)\mu_i - \left(s_k/\beta_k\right)\mu_k$, $Z_i^D \equiv 1 - d\pi_i^D/dw_{ij}^D = 1-\xi_i/N_i$, $\xi_i \equiv C_i/G_i$, $C_i \equiv \eta\left[\left(\eta/\chi\right)s_i - s_k/\beta_i - \left(\eta^2/\chi\right)\left(s_i/\beta_k + s_k/\beta_i\right)\right]$, $G_i \equiv 1+\left(\eta^2/\chi\right)s_k - \eta s_i/\beta_k + C_i$.[12] In comparison with the corresponding expression (6) for the national case, Ξ_i is a currency-union extension which includes not only – as in (6) – the domestic supply shock, x_i, but also – in connection with the operation of the single monetary policy – the foreign supply shock and both the own and foreign demand shocks. Moreover, in analogy to the national case, Z_i^D captures the extent to which nominal wage increases (i.e. rises in w_{ij}) translate into higher real wages. Finally, as with (6), in (9) many parameters

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[11] An equation analogous to (9) can be derived for the wage premium of country k - country i's partner in the currency union - in terms of that of country i. In deriving (9), we use the approximation $\bar{\Phi}_i^D\, x_i = 0$.

[12] In order to derive $\bar{\Phi}_i^D$, we make use of the equilibrium expressions $R^D = \left(\eta^2/\chi+\eta/\beta_i\right)s_i\,\bar{\Phi}_i^D + \left(\eta^2/\chi+\eta/\beta_k\right)s_k\,\bar{\Phi}_k^D - \left(\eta^2/\chi+\eta/\beta_i\right)s_i x_i - \left(\eta^2/\chi+\eta/\beta_k\right)s_k x_k + \left(s_i/\beta_i\right)\mu_i + \left(s_k/\beta_k\right)\mu_k$, $y_i^D = -\eta\left(\bar{\Phi}_i^D - x_i\right)$ and $\pi_i^D = R^D + \left(y_i^D - \mu_i\right)/\beta_i$. These expressions represent the interest rate reaction function, and the equilibrium output and inflation levels. Altogether, they lead to $\pi_i^D = \xi_i\left(\bar{w}_i^D - w_i^{rc}\right) + \nu_1\left(\bar{w}_k^D - w_k^{rc}\right) + \nu_2 x_i + \nu_3 x_k + \nu_4\mu_i + \nu_5\mu_k$, where the ν_i's are constants.

enter the determination of the wage premium. It is worth noting that this time real-demand-side parameter β_i is one of those parameters; by affecting the wage premium it also exerts an influence on domestic inflation and the level of economic activity (as measured by either output or the unemployment rate), instead of simply contributing to determine the interest rate as under regime *N*.

4. The effects of unions that care about national prices: Two specific cases

This section investigates the effect of allowing for unions that care about national prices, in comparison with autonomous monetary policy. In so doing, we look only at the deterministic case while considering - by way of illustration - only baseline parameter values. We leave for the next section the study of more general setups, as given by the deterministic case for a range of plausible parameter values, and the stochastic case for a range of plausible parameter values and macroeconomic shocks.

Here we focus on the comparison of real wages between regimes *D* and *N*, as given by the difference $\bar{\Phi}_i^D - \bar{\Phi}_i^N$ for unchanged parameter values. Once this is known, it is possible to determine the effect of moving from *N* to *D* on national output and unemployment in the two countries from $y_i^m = -\eta \bar{\Phi}_i^m$ and $\bar{u}_i^m = \alpha \bar{\Phi}_i^m$, respectively, for $m = N, D$; for inflation, see (5) and footnote 12 (switching shock terms off).

Define $\beta^* \equiv (\beta^2 - \delta^2)/[\beta - (1-2s_i)\delta]$ and $\tilde{\beta} \equiv (\beta^2 - \delta^2)/[\beta + (1-2s_i)\delta]$, where β is a constant central value and δ is a constant cross-country dispersion coefficient, both of them associated with the interest rate sensitiveness of aggregate demand. In the following, we consider two cases concerning this interest elasticity: A) $\beta_i \equiv \beta + \delta$ and $\beta_k \equiv \beta - \delta$, and B)

$\beta_i \equiv \beta - \delta$ and $\beta_k \equiv \beta + \delta$. We assume $\beta > \delta$ and $\delta \geq 0$, which ensures that $\beta_i > 0$ for all i=1,2.

REMARK 1: $Z_i^D > (<) Z_i^N$ if $\eta < (>) \beta^*$ in Case A and/or if $\eta < (>) \tilde{\beta}$ in Case B.

Variables Z_i^m measure the effectiveness of changes in the nominal wage in bringing about changes in the real wage. Their gap across regimes is given by $Z_i^D - Z_i^N \equiv \left[\left(\eta^2 / \chi \right) + \eta / \beta_i \right] s_k / \left(N_i G \right)$, whose sign equals that of G, being positive (negative) for $\eta < (>) \beta^*$ in Case A and/or for $\eta < (>) \tilde{\beta}$ in Case B.[13] This establishes Remark 1.

One corollary follows from Remark 1: If the two countries are identical in size ($s_1 = s_2 = 1/2$) and share the same interest-elasticity of aggregate demand ($\beta_1 = \beta_2 = \beta$), then $Z_i^D > (<) Z_i^N$ simply when $\eta < (>) \beta$. Intuitively, when – say – $\eta > \beta$ unions obtain a lower real wage raise under regime *D* since at the margin the SMA allows for higher inflation than in the national case, displaying a relatively strong focus on output (due to losses from a high η) and a muted real impact of policy via aggregate demand (small enough β).

4.1 A monetary union between identical countries

When the two countries are identical in size ($s_1 = s_2 = 1/2$), the number of unions ($N_1 = N_2 = N$), the degree of substitutability between labour ($\gamma_1 = \gamma_2 = \gamma$) and the interest-

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[13] Cases A and B are not mutually exclusive for $\delta = 0$, in which case both $\eta < (>) \beta^*$ and $\eta < (>) \tilde{\beta}$ hold. This is the only reason for using the expression “and/or” in this paper, instead of simply “or” – the latter characterising all cases with $\delta > 0$. In order to save on notation, in the next section we shall redefine Cases A and B to hold only for $\delta > 0$, while we shall introduce Case C, which corresponds to the situation where $\delta = 0$ and thus $\beta_i = \beta_k = \beta$.

elasticity of aggregate demand ($\beta_1 = \beta_2 = \beta$), the premium demanded by unions becomes $\bar{\Phi}^m = Z^m / \left[H^m + B(\eta^2/\chi)(1-Z^m)\right]$, for $m = N, D$, where $H^m \equiv \alpha A\left[\alpha Z^m + \gamma(N-1)\right]$.
Comparison of the wage premium between the two regimes leads to:

PROPOSITION 1: *In case union and central bank preferences are identical across countries, if $\eta < (>) \beta$ then the wage premium in a monetary union when trade unions care about national prices is higher (lower) than under monetary autonomy.*

The gap between the wage premium under monetary autonomy and the currency union equals

$$\zeta \equiv \bar{\Phi}^D - \bar{\Phi}^N = \frac{\left[\gamma_i(N_i - 1) + B(\eta^2/\chi)\right](Z^D - Z^N)}{\left[H^D + B(\eta^2/\chi)(1-Z^D)\right]\left[H^N + B(\eta^2/\chi)(1-Z^N)\right]}$$

whose sign equals that of $Z^D - Z^N$. Each union correctly perceives that if $\eta < (>) \beta$ the impact of a unit increase in the nominal wage on its real wage is higher (lower) in regime *D* compared to regime *N* ($Z^D > (<) Z^N$; see Remark 1). When $\eta < (>) \beta$, unions that care about national prices engage in less (more) moderation in wage demands through the two channels studied in CL under monetary union. The first operates through unions' inflation concern (*B>0*) and the second through a mitigation of the adverse competitive effect of an increase in inflation (when $\gamma > 0$ and $N > 1$).

A quantitative assessment of these results is possible by comparing plausible values for η (involving σ, λ and s_L) and β. In our baseline calibration (see section 6), $\sigma = 0.5$, $\lambda = 6$ and $s_L = 0.65$, implying $\eta = 1.48$. Setting the baseline parameter value for β is more complicated. We choose a value of 0.9, which is somewhat higher than 0.6 in Ball (1999) and reflects recent findings in the microfounded open-economy literature.[14] In any case, for a

[14] More precisely, a value of 0.9 for β could be derived from Erceg et al.'s (2007) "open-economy" calibration for their interest-elasticity of aggregate demand (the equivalent to our β in Proposition 1), after controlling for

range of plausible values for β, it seems likely that $\eta > \beta$, in which case non-atomistic unions' $(N < \infty)$ wage premium is lower in regime *D* than in regime *N*. The lower wage premium implies reduced area-wide inflation in (8); unemployment goes up and output falls (in every country) by less in regime *D* than in regime *N*.

4.2 A monetary union between heterogeneous countries that do not care about inflation

When unions are not inflation averse (*B=0*), the wage premium can be expressed as $\bar{\Phi}_i^m = Z_i^m / H_i^m$, for $m = N, D$, where $H_i^m \equiv \alpha A\left[\alpha Z_i^m + \gamma(N-1)\right]$. Comparison of the wage premium under regimes *N* and *D* leads to:[15]

PROPOSITION 2: *In case unions do not care about inflation stability (B=0), there is a finite number of unions* $(1 < N_i < \infty)$ *and some competitiveness between them* $(\gamma_i > 0)$*, if* $\eta < (>) \beta^*$ in Case A and/or if $\eta < (>) \tilde{\beta}$ in Case B *then the effect of a currency union on the wage premium when trade unions care about national prices is:*

(i) positive (negative) in both countries;

(ii) greater (smaller) in countries characterised by intermediate levels of centralisation of wage bargaining (N_i *) and labour market competitiveness (* γ_i *).*

Result (i) states that the presence of unions that care about national prices increases (reduces) real wages when $\eta < (>) \beta^*$ in Case A and/or if $\eta < (>) \tilde{\beta}$ in Case B. For instance, if $\eta > \beta^*$ and/or if $\eta > \tilde{\beta}$ unions that care about national prices each of them internalises the

government spending. The corresponding value for the authors' "closed economy" calibration would be β =0.4. For more details, see the discussion in the next section.

[15] See the Appendix for a formal proof.

inflationary impact of its individual action, and the associated deterioration in competitiveness, to a greater extent than under regime *N*. In equilibrium, all unions adopt a less aggressive wage strategy in regime *D*, which results in lower real wage premia in all countries.

From result (ii), regime *D* has the largest effect at intermediate levels of centralisation of wage bargaining (N_i) and labour market competition (γ_i). The reason is that when either N_i or γ_i is large, labour market performance converges to the market-clearing level in both regimes *D* and *N*. At the other extreme, when $N_i = 1$ or $\gamma_i = 0$ the degree of competition in the labour market is zero; the presence of unions that care about national prices thus fails to affect the wage premium because the adverse competitiveness effect does not operate.

Finally, we carry out a deterministic simulation exercise in the context of Proposition 2. We do so with the aim of establishing how likely it is that $\eta > \beta^*$ as opposed to $\eta < \beta^*$ in Case A, and similarly how likely it is that $\eta > \tilde{\beta}$ in contrast with $\eta < \tilde{\beta}$ in Case B. The parameters that are involved in Proposition 2 as follows. Due to either β^* or $\tilde{\beta}$, we need to consider the size parameter, s_i, the interest elasticity parameter, β, and the dispersion parameter associated with the latter, δ. And, due to $\eta \equiv s_L \kappa\sigma / (\kappa - s_L)$, we look at the inverse of the price mark-up, $\kappa \equiv 1 - 1/\lambda$ (which in turn involves the price elasticity of demand faced by firms, λ), the labour share parameter, s_L, and technology parameter σ.

The ranges considered for the parameters involved are as follows. In line with the literature, s_L is set to a constant value (0.65) across all simulations. Grids are set up for two parameters (s_i and δ) over plausible ranges (see Tables 2 and 3, as well as details below, for the latter). For λ, we consider the range [3,10]. For the two remaining parameters, we allow for two different ranges, as justified by two possible readings of the literature (a looser and a more restrictive one): [0.4-2.5], and alternatively [0.4-5], for β; and [0.2,1] , and alternatively (0-2.4], for σ. The justification for these choices is delayed to section 5.

The results from the simulations undertaken here are presented in Tables 2 and 3. For any given values of s_i and δ, the probabilities that $\eta > \beta^*$ in Case A, and that $\eta > \tilde{\beta}$ in Case B, – which correspond to scenarios of wage restraint – are above ½ when the maximum for β is set to a baseline value of 2.5 (panel A in both Tables). In contrast, the probability that the opposite events occur (that is, the probabilities that $\eta < \beta^*$ in Case A, and $\eta < \tilde{\beta}$ in Case B) exceeds ½ only for the (relatively unrealistic) case when the maximum for β is set to considerably higher maximum of 5 (panel B in both Tables). It is worth mentioning that, even for the latter case, the odds attributed to wage restraint exceed the (zero) value attached in the seminal CL contribution.

We have also considered the possibility of drawing from a wider range in the case of σ (panel C in both Tables 2 and 3), but this does not appear to change the results much. Finally, we report some ambiguous results concerning the role of s_i in affecting the likelihood of wage restraint, as given by the probability that $\eta > \beta^*$ or that $\eta > \tilde{\beta}$.[16]

5. Simulations for the general case

In section 4 we went beyond concentrating on the theoretical results for the previous two special cases also studied by CL. We did so by looking at likely baseline results for parameter values, as well as undertaking a deterministic simulation exercise in the context of Proposition 2. In the present section, we go even further from that by carrying out simulations for more general situations, allowing the two countries to differ in all possible characteristics

[16] Indeed, the effect of a – say – higher s_i on those probabilities appears to change sign depending on the value of δ.

that are considered in our framework – including the presence of shocks. In so doing, we draw on the full range of plausible parameter values under both deterministic and stochastic setups. While our focus is on wage restraint (and in particular the wage premium, $\bar{\Phi}$, and the wage share, Ω), we also report developments in other macroeconomic variables such as inflation, output and unemployment. We are interested in both baseline simulation results and the degree of variability surrounding them.

More specifically, we distinguish between three types of parameters, mostly reflecting the information we have about them. It is worth mentioning that, in the case of the ranges relating to parameters already used in the previous section's simulation, we largely maintain exactly the same assumptions when performing the draws here. In some ways, however, the exercise differs from the one carried out at the end of section 4: here we set a fixed value (as opposed to a grid) for s_i; and we draw β_i and β_k directly, only implicitly defining the variability around a central value, β (and thus altogether ignoring dispersion parameter, δ). First, a subset of the parameters are simply set to constant values across all simulations. In this regard, we set s_i to 0.1, which implies adopting a large difference in size between the two countries.[17] Broadly in line with the literature, we set $s_L = 0.65$. Moreover, lacking any precise estimates for trade unions' preference parameters we choose "neutral" value $A = 1$. Second, some parameters are set to a few (in the present application, simply two) different constant values, even as for each of these constant values other parameters are allowed to move significantly more freely. This is the case of χ, for which we use a benchmark value of

[17] One possible justification for this is that our two-country monetary union may in part capture what happens in a union between more than two countries, which are then be regrouped in two for simplicity. For instance, the distinction between a small and a large country may be a useful simplified representation of a multi-country currency union comprising a smaller number of relatively large countries (regrouped in a single "large" country) and a larger number of relatively small participating economies (regrouped in a single "small" country).

2.5, which is very close to Broadbent and Barro's (1997) estimate using US data, and the much higher value of 500 used by Gaspar et al. (2007). In the case of the number of trade unions, we choose benchmark values of $N_i = N_k = 10$, while also considering a widely used value of $N_i = N_k = 1$.[18] Third and lastly, for the remaining parameters we choose ranges of values over which we sample uniformly. For instance, we consider the ranges [0-1] for B, [3,10] for γ_i, [3,10] for γ_k, and [3,10] for λ.[19] For the two remaining parameters, as mentioned in section 4, we allow for two different ranges: [0.4-2.5], and alternatively [0.4-5], for both β_i and β_k; and [0.2,1] , and alternatively (0-2.4], for σ. In the cases of β_i and β_k, we report all simulation results for each possible range used, whereas in the case of σ we treat the two possible ranges (the latter being used as an alternative) more simply as a reasonable robustness check. For σ, the more restrictive version of the ranges is derived by the emphasis in Rowthorn (1999), and the more recent evidence in Jalava et al. (2006), Klump et al. (2007a, 2007b), and Ripatti and Vilmunen (2001). The broader range for σ is based on Rowthorn's (1996) comprehensive survey. As mentioned in the previous section, setting values for β is rather involved. In this paper we choose a baseline value of 0.9, which is somewhat above 0.6 in Ball (1999). For the baseline value and ranges surrounding them,

[18] For the latter case of monopoly trade unions at the country level, see e.g. Grüner (2002), Grüner and Hefeker (1999) and Sørensen (1991).

[19] With regard to *B*, the range is derived from the fact that the literature does not always make use of the inflation aversion motive in unions' loss function (e.g. B>0 in Cukierman and Lippi, 2001, and Coricelli et al., 2004, while B=0 in Coricelli et al., 2006, and Cukierman and Dalmazzo, 2006). Concerning the ranges for substitutability parameters γ_i, γ_k, and λ, see e.g. Erceg et al. (2007), Rabanal and Rubio-Ramírez (2005 and 2008), and Smets and Wouters (2003, 2005, 2007).

we take into account the microfounded open-economy literature.[20] As said earlier, using Erceg et al.'s (2007) calibrations, the interest-elasticity of aggregate demand (β in our paper) would range from 0.4 in a closed economy to 0.9 in an open economy, after controlling for government spending. Erceg et al.'s (2007) calibrations are conducted in a more elaborate (DSGE) framework than the one set up here. They show that their calibration for the interest-elasticity of aggregate demand depends positively on the value of the trade elasticity, for which they set a baseline value of 1.5. Macroeconomists tend to think it is low, in a range between 1.2 and 2.[21] In contrast, the micro/trade literature typically believes that such elasticity is very high, for instance, Bernard et al. (2003) set it at 4. One recent DSGE study by Adolfson et al. (2007) estimate the trade elasticity to range from 0.5 to 5, depending on the treatment of imports. The highest value among all these estimates (that is, 5) would imply a value of the interest-elasticity of aggregate demand $\beta = 2.5$. In the simulations reported in the present section, we use this value as the baseline maximum for β, while checking for the robustness to a considerably higher maximum of $\beta = 5$.

In addition to drawing parameter values uniformly over plausible ranges, in our stochastic setup we draw demand and technology shocks from truncated normal distributions. More concretely, technology shocks x_i and x_k are drawn independently from a normal distribution N(0,0.05) between values -0.1 and 0.1. This constraint is justified by the need to keep the values of these shocks relatively small for our model approximations to be accurate enough.

[20] More precisely, an "open-economy" value of 0.9 for β could be derived from Erceg et al.'s (2007) calibrations, where reasonable values for the interest-elasticity of aggregate demand (β in Proposition 1) range from 0.4 in a closed economy to 0.9 in an open economy, after controlling for government spending. For more details, see the discussion in the next section.

[21] For instance, representative estimates are: Heathcote and Perri (2002) at 0.9, Lubik and Shorfheide (2005) at 0.4, De Walque et al. (2006) in the range from 1.2 to 1.7, Corsetti et al. (2008) at 0.5.

Moreover, real demand shocks μ_i and μ_k are drawn independently from a normal distribution N(0,0.15) between -0.3 and 0.3. The latter decision is motivated by two considerations: i) Rabanal's (2008) result that demand disturbances are about three times more volatile than technology shocks; and ii) the way technology shocks are drawn.

Our approach to simulation is related to that used e.g. in Canova and Pappa (2007) and Canova et al. (2008). We report mean and median results, alongside confidence bands for 16 and 84 percentiles. We employ 10000 raw draws, which in the stochastic case become approximately 8200 effective draws in light of the truncation applied in dealing with shocks.

Tables 4 through 6 report the main simulation results and robustness checks for the deterministic and stochastic versions of the model. Tables 4 and 5 report the main results for our simulation analysis for the deterministic and stochastic versions of the model, respectively. In both cases, a comparison between our results indicates that the median results for area-wide real wages are similar for the currency union and the national case. Concentrating on the cases of union-wide variables, median results for the wage premium are slightly more muted in the currency union case. The same can be said about the area-wide values of macro variables influenced by real wages, such as the wage share, inflation, real output and the unemployment rate. In any case, the simulations do not support Cukierman and Lippi's (2001) unambiguous finding of more aggressive wage setting under monetary union. In addition, we detect a relatively large degree of variability of the simulations around the median response, with this variability being naturally smaller in the deterministic case and also tending to be more muted in the cases of the wage premium and – in the stochastic case - the unemployment rate. All these conclusions appear to be robust to using a maximum value for the β's equal to 5 or the more reasonable of 2.5 while still drawing from other parameters which are allowed to vary within a plausible range.[22]

Table 6 presents robustness checks to our simulation analysis under the deterministic and stochastic versions of the model, concentrating exclusively on wage premium results.[23] These robustness checks include the cases when χ=500 (panel A), the number of trade unions equal $N_i = N_k = 1$ (panel B), and σ is drawn from a wider range of values (panel C). In all of these cases, the variability in the simulations for the wage premium tends to be larger not only in the deterministic case but also in the stochastic setup. Overall, the main message stemming from these simulations is not much changed from our previous main results. Some case-specific results are reported, but it is worth emphasising that they are thwarted by the uncertainty surrounding them as determined by the parameter values and shocks drawn. Among these case-specific results, it is possible to detect that, while relatively similar between each other, median responses tend to be slightly more muted in the stochastic case than the deterministic setup both for the national case and monetary union when we set χ=500. Moreover, in case $N_i = N_k = 1$ median responses for the union-wide wage premium are somewhat lower under monetary union in the deterministic case when β is drawn between 0 and 2.5. Finally, when σ is drawn from a wider range of values, responses for the union-wide wage premium in the national case are slightly lower for stochastic as opposed to deterministic simulations, thereby contributing in such case to close the gap vis- à-vis monetary union.

[22] There is also a large degree of asymmetry, as gauged for instance by a considerable discrepancy between the median and the mean. The mean for area-wide real wages tends to be below that for real wages in the national case. Similarly, the monetary union often delivers lower levels of inflation, wage share and unemployment rate, as well as higher real output.

[23] The full set of results is available from the author upon request.

6. Welfare analysis

The analytical results found in section 4 are qualitative, and as such do not indicate the size of the performance differences between regimes, nor how sensitive they are to variations in key parameter values. Moreover, precise analytical results have been derived only for the two cases also studied by CL, namely, a monetary union between identical countries and a monetary union between heterogeneous countries that do not care about inflation. This section turns to the quantitative analysis of welfare in a currency union relative to that obtained under autonomous monetary policy. We consider both real demand- and supply-side disturbances.

Our analytical results from last subsection have shown that demand schedule parameter β_i affects the single monetary policy response to forces driving macroeconomic developments and thus welfare. As with section 5, we allow β_i to display cross-country variation. Once more, in our baseline calibration we choose β=0.9, with the associated dispersion parameter δ being set to 0.1. Again, our benchmark value for s_i is 0.1; while this means that we focus on the case of a small country, our sensitivity analysis will allow s_i to range up to 0.5 (that is, the case of equally-sized member states). Among other benchmark values, we set $s_L = 0.65$, $\lambda = \gamma_i = \gamma_k = 6$, χ = 2.5, $\sigma = 0.5$ and $N_i = N_k = 10$. Finally, lacking any precise estimates for trade unions' preference parameters we choose "neutral" values $A = B = 1$.

Our sensitivity study allows parameters to vary over the ranges [0.6-3] for β, [0.05,0.5] for δ, [0.5-5] for s_i, [0.-5] for χ, [0.5-5] for A, [0.5-5] for B, [2,20] for N_i, [2,20] for N_k, [3,10] for γ_i, [3,10] for γ_k, [0.2,1.4] for σ, and [3,10] for λ.[24]

[24] We consider that these are reasonable parameter values. They are however allowed to differ from those used in the previous section (which best reflect the ranges considered in the literature) for presentational purposes.

Depending on the values for β_i among the currency union's member states, we distinguish between three types of reference country *i*. First, in Case A the reference country exhibits a high supply slope parameter, that is, $\beta_i = \beta + \delta$ (with $\beta_k = \beta - \delta$). Second, in Case B the reference country possesses a low supply slope parameter, that is, $\beta_i = \beta - \delta$ (with $\beta_k = \beta + \delta$). Third, in Case C we do not allow for cross-country variation in supply slope parameter β_i, in which case the reference country *i* displays the average value, $\beta_i = \beta_k = \beta$, for this parameter.

Equilibrium values for y_i^D and π_i^D can be plugged into (7) to compute the value of country *i*'s loss function under monetary union participation. That value can be denoted by Γ_i^u. A welfare comparison can be carried out by relating that value to Γ_i, which is the loss obtained using y_i^N and π_i^N under monetary autonomy in expression (2). More precisely, we look at the ratio $C_{uI} \equiv \Gamma_i^u / \Gamma_i$ in order to study the sensitivity of a currency union's relative stabilisation performance to changes in parameter values.[25] In particular, a decrease in C_{uI} means that country *i* enjoys a lower loss, and thus higher welfare, from participating in a currency union.

As already mentioned, we carry out sensitivity analysis of welfare ratio C_{uI} with respect to parameter values. In so doing, we consider the three scenarios of common, idiosyncratic and asymmetric supply shocks, allowing for either uniform or country-specific demand slope parameters. We define different types of shocks according to their distribution across the union, namely: (i) asymmetric; (ii) idiosyncratic; and (iii) common. Shocks are normalised to be small, in light of the discussion in section 2 surrounding x_i. More concretely, we set to $\varepsilon = 0.1$ the magnitude of all shocks for country *i*, which is - without loss of generality - the

[25] See Sánchez (2007, 2008a, 2008b) for related approaches.

focus of our comparisons across regimes. Asymmetric shocks are defined to be shocks such that they add up to zero at the currency union level; in particular, country i of size s_i is assumed to face a shock equal to ε, while the remaining country faces a shock equal to $-(s_i / s_k)\varepsilon$. Idiosyncratic shocks are those in which shocks to country i equal ε, and shocks to the other country equal 0. Finally, common shocks are defined to be shocks such that both countries face a shock equal to ε.

Figures 1 through 12 show how the relative welfare loss (as measured by the ratio C_{uI}), changes in relation to the twelve above-mentioned parameters in the event of technology shocks. Figures 13 through 24 display the corresponding welfare comparisons under demand shocks.

In Figures 1 and 13, we consider the effects on relative stabilisation performance of varying β, the central value for the interest elasticity parameter, under technology and demand shocks, respectively. An increase in β indicates an across-the-board higher responsiveness of inflation to the output gap on the demand side, that is, a steeper real demand schedule. In the case of country-specific disturbances, a higher β is mostly beneficial for the currency union (relative to monetary autonomy), in part because, for a given value of δ, an increase in the central value for the interest elasticity coefficient implies an increasingly homogenising effect across countries. It is noteworthy that there is an irregular development at around $\beta = 1.5$, that is, for the value at which β becomes larger than η. At that point, the ranking between the degree to which nominal wage demands induce a rise in real wages in regimes D and N (that is, the ranking between Z_i^D and Z_i^N) switches from negative to positive. Turning to common shocks, it is necessary to distinguish between technology and demand disturbances. Under common technology shocks, depending on whether one considers the country with the flatter (steeper) real demand schedule - that is, for a type-A(B) country - a higher β lowers (raises) macroeconomic volatility, implying that the currency union's stabilisation properties improve (worsen) – compared with monetary autonomy.[26] The situation is unchanged in the case of homogenous real demand curves (Case C). In the face of common demand shocks, increases in β from a low level induce an amelioration of monetary union stabilisation performance in both cases (A and B) with country-varying real demand slopes.[27] Furthermore, as with country-specific shocks, kinks appear at around $\beta = 1.5$, that is, when further increases in β make this coefficient exceed the value of η.[28]

Figures 2 and 14 report sensitivity analysis for δ, the cross-country dispersion in the interest elasticity coefficient, for the cases of technology and demand disturbances, respectively. For country-specific shocks, an increase in δ induces an improvement in monetary union performance for the country with the flatter demand curve (Case A) and a deterioration for the country with the steeper demand schedule (Case B). In the event of common shocks, the result for both countries appears to be that a higher δ favours monetary autonomy over a currency union, with the exception of Case B under technology disturbances under low-to-moderate values of the dispersion parameter. One factor behind such deterioration in monetary union stabilisation performance is given by adverse spillover effects emanating from the enhanced cross-country discrepancy in the interest sensitiveness of real demand.

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[26] In light of country-specific demand schedule slopes, a higher β makes both countries' schedules flatter, therefore calling for a smaller interest rate reaction. As a result, a type-A country benefits from smaller spillovers stemming from the other country's (always steeper) slope, while the opposite welfare effect takes place for a type-B country.

[27] The impact of a common demand shock ($\mu_i = \mu_i = 0.1$) is affected by factor $1/\beta_i - 1/\beta_k$ in Ξ_i. For country-specific demand slopes, such factor is decreasing (in absolute terms) in β at the pace $2\delta/\left(\beta^2 - \delta^2\right)$.

[28] As we have seen, $Z_i^D - Z_i^N$ is negative for $\beta < \eta$, while $Z_i^D - Z_i^N$ is positive for $\beta > \eta$. In both cases, a higher β induces a reduction in absolute terms in this gap.

Figures 3 and 15 show the welfare results from varying s_i, the country size parameter. An increase in s_i affects welfare only in the currency union. In the case of idiosyncratic disturbances, the increase in a country's own size tends to induce a favourable effect from currency union participation as it implies that the single monetary policy puts a larger weight on the country's macroeconomic variables. An increase in country size also contributes to an amelioration in monetary union stabilisation performance under common demand disturbances. In the face of asymmetric and common technology shocks, the results depend on the country type, favouring currency union membership (monetary autonomy) in the cases of type-B(A) and type-A(B) countries, respectively.[29]

In Figures 4 and 16, we report sensitivity analysis for the central bank's preference parameter χ. For country-specific shocks, the rise in χ (capturing an enhanced conservativeness on the part of monetary policy) exerts an adverse influence on a currency union's stabilisation properties. In the event of common shocks, a higher preference for price stability has different welfare implications depending on the interest rate sensitiveness of each country’s real demand. In Case A, an increase in χ favours monetary autonomy, while in Case B this parameter change relatively improves (worsens) currency union participation in the face of technology (demand) disturbances. For common shocks, a higher preference for price stability fails to affect the relative welfare between the national case and a monetary union.

Turning to trade unions’ preference coefficients, Figures 5 and 6 display welfare results for parameters *A* and *B* under technology shocks, respectively, while Figures 17 and 18 show the corresponding sensitivity results for the case of demand disturbances. In the case of unemployment aversion coefficient *A*, under technology shocks a higher value of this

[29] In the event of these types of shocks (that is, asymmetric shocks and common technology disturbances), a higher s_i entails no effect at all under homogeneous demand slopes (Case C).

parameter improves monetary union stabilisation performance, capturing the internalisation of macroeconomic effects on the part of wage setters whose actions also impact the supply-side of the economy. In contrast, in the face of demand disturbances a rise in trade unions' unemployment aversion is found to favour monetary autonomy (except for unchanged results under common such shocks). Regarding inflation aversion parameter *B*, both in the presence of technology and demand shocks varying values of this coefficient fail to have a visible impact o relative welfare, which can be rationalised in terms of monetary policy-makers already taking care of inflation variability (even if with a focus that is different from those of trade unions).

Among other results, we detect contrasting welfare implications of the parameters concerning the number of unions in each country. An increase in N_i is seen to favour currency union membership under technology shocks (especially at low values of the parameter), while the opposite result can be observed under demand disturbances (Figures 7 and 19). A rise in N_k has welfare implications that depend on both the type and the cross-country distribution of the shocks (Figures 8 and 20). More concretely, a higher N_k improves monetary union stabilisation properties for country-specific technology shocks and common demand disturbances, but it favours monetary autonomy in the remaining cases (that is, common technology shocks and country-specific demand disturbances). For the coefficients for the labour substitutability across unions, γ_i and γ_k (which also affect the degree of competition in the labour market), we similarly report contrasting welfare implications – in Figures 9-10 and 21-22.

Finally, we analyse welfare implications of two parameters contributing to determine supply slope, η. A higher value of σ, the production function substitution coefficient, generally supports currency union participation, except at low values in the event of demand shocks (Figures 11 and 23). A rise in λ, the mark-up coefficient in the goods market, entails unfavourable consequences for monetary union stabilisation performance, with the exception of low values under demand disturbances (Figures 12 and 24).

7. Conclusions

Trade unions are here realistically modelled as caring about national prices when setting wages, deviating from Cukierman and Lippi's (2001) assumption that unions set wages with area-wide prices in mind. Our assumption that trade unions care about national prices when setting wages brings into the analysis the output side of the economy. In particular, we allow for a varying wage share on the supply side, while also allowing for interest rate sensitiveness of real demand. Our main finding is that, contrary to Cukierman and Lippi (2001), results from our extended model are parameter-dependent, thus failing to establish as a general conclusion that monetary union triggers aggressive wage demands.

We follow two main approaches. First, we derive analytical results using a deterministic model under the two special cases considered by Cukierman and Lippi (2001), namely, identical countries and the absence of inflation aversion on the part of trade unions. This setup is also illustrated by means of baseline parameter values. In contrast with Cukierman and Lippi (2001), we find that the question whether monetary union alters real wages compared with those obtained under monetary autonomy does not have an unambiguous affirmative answer. That is, the actual answer turns out to depend on specific values assigned to the model parameters. We have thoroughly examined the likelihood of wage restraint in a case where we allow for some degree of heterogeneity across member countries. The odds in favour of wage restraint appear to be non-negligible, in contrast with the findings in CL. This result is obtained from deterministic simulations, which in particular suggest that the probability of a wage restraint scenario is rather likely under our baseline parameterisation. Second, we draw on the full range of plausible parameter values under both deterministic and stochastic setups. We find that median macro developments are found not to be much altered by monetary union, while mean developments point to monetary union delivering extra wage moderation, lower levels of inflation, unemployment and wage share, and higher activity levels. Unlike Cukierman and Lippi's (2001), our results are thus not at odds with the evidence of wage restraint often reported since the launch of the euro in 1999. In obtaining our results, we do not resort to effects stemming from globalisation or enhanced monetary policy credibility (Posen and Gould, 2006). It is worth saying that our simulation analysis points to considerable variability surrounding baseline simulation results, depending on parameter (and shock) values drawn. This finding points to caution when using the general class of models to which the one used here belongs.

Finally, our study of monetary stabilisation in a currency union includes welfare comparisons in the face of technology and demand shocks. We show that the main results depend on the distribution of shocks across the union, as well as on key structural parameters. In particular, the aggregate demand slope, labour substitutability across unions, and the number of wage-setting institutions are allowed to be country-specific, with the monetary policy response depending on all these sources of structural heterogeneity.

Appendix: Proof of proposition 2

When unions set wages with national prices in mind, but do not express concern about price stability *(B=0)*, the difference between the wage premium of country *i* under a currency union and that under monetary autonomy equals

$$\zeta_i \equiv \bar{\Phi}_i^D - \bar{\Phi}_i^N = \frac{\gamma_i (N_i - 1)(Z_i^D - Z_i^N)}{\alpha A[\alpha Z_i^D + \gamma_i (N_i - 1)][\alpha Z_i^N + \gamma_i (N_i - 1)]} \qquad (A.1)$$

where $Z_i^N \equiv 1 - \theta / N_i$ and $Z_i^D \equiv 1 - \xi_i / N_i$. The difference is positive (negative) for all $N_i > 1$ or $\gamma_i > 0$ when $\eta < (>) \beta^*$ in Case A and/or when $\eta < (>) \tilde{\beta}$ in Case B. This in turn implies $Z_i^D > (<) Z_i^N$ (see Remark 1), thus proving part (i).

Part (ii): The partial derivatives $\partial \zeta_i / \partial N_i$ and $\partial \zeta_i / \partial \gamma_i$ are given by

$$\frac{\partial \zeta_i}{\partial N_i} = \frac{\gamma_i (Z_i^D - Z_i^N) \Psi_i}{\alpha A F_i^2}; \quad \frac{\partial \zeta_i}{\partial \gamma_i} = \frac{(N_i - 1)(Z_i^D - Z_i^N)[\alpha^2 Z_i^D Z_i^N - \gamma_i^2 (N_i - 1)^2]}{\alpha A F_i^2} \qquad (A.2)$$

where

$$\Psi_i \equiv F_i / N_i - (N_i - 1)\{\gamma_i (N_i - 1)[2\gamma_i + a(\xi_i + \theta s_i)/ N_i^2] + \gamma_i \alpha [2 - (\xi_i + \theta s_i)/ N_i] + \alpha^2 [(\xi_i + \theta s_i) - 2(\xi_i \theta s_i)/ N_i]/ N_i^2\}$$

and $F \equiv [\alpha Z_i^D + \gamma_i (N_i - 1)][\alpha Z_i^N + \gamma_i (N_i - 1)]$. The first (second) expression in (A.2) is continuous in N_i (γ_i) for $N_i > 1$ ($\gamma_i > 0$). For $\eta < \beta^*$ in Case A and/or if $\eta < \tilde{\beta}$ in Case B, the first (second) equation in (A.2) is positive at $N_i = 1$ ($\gamma_i = 0$), negative for a sufficiently large N_i (γ_i) and converging towards zero from below as $N_i = 1$ ($\gamma_i = 0$). For $\eta > \beta^*$ in Case A and/or if $\eta > \tilde{\beta}$ in Case B, the first (second) expression in (A.2) is negative at $N_i = 1$ ($\gamma_i = 0$), positive for a sufficiently large N_i (γ_i) and converging towards zero from above as $N_i = 1$ ($\gamma_i = 0$). Since the two expressions in (A.2) switch signs only once in each case considered, it follows that, if $\eta < (>) \beta^*$ in Case A and/or if $\eta < (>) \tilde{\beta}$ in Case B, then the difference ζ_i has a unique global maximum (minimum) at intermediate values of N_i and γ_i. This establishes part (ii).

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Table 1. Decomposition of the wage share
changes over 5-year periods (in %)

A. Euro area

	1980-1985	1985-1990	1990-1995	1995-2000	2000-2005
Total	**-2.8**	**-2.2**	**-1.4**	**-1.1**	**-1.5**
Intra-sectoral effect	-2.1	-1.6	-0.6	-0.7	-1.0
Structural effect	-0.8	-0.6	-0.8	-0.4	-0.5
Static effect	-0.8	-0.4	-0.8	-0.5	-0.4
Dynamic effect	0.0	-0.2	0.0	0.1	-0.1

Source: EU KLEMS and ECB staff calculations.
Notes: The euro area does not include Cyprus, Malta and Slovenia. Values may not add up due to rounding.

Table 2. Probability that $\eta > \beta^*$ under selected scenarios

A) Drawing β between 0.4 and 2.5 (baseline)

	$s_i = 0.1$	$s_i = 0.3$	$s_i = 0.5$	$s_i = 0.7$	$s_i = 0.9$
$\delta = 0$	0.65	0.62	0.59	0.57	0.55
$\delta = 0.1$	0.65	0.63	0.63	0.63	0.63
$\delta = 0.2$	0.65	0.65	0.66	0.67	0.69
$\delta = 0.3$	0.65	0.66	0.68	0.71	0.73
$\delta = 0.4$	0.65	0.68	0.71	0.74	0.77

B) Drawing β between 0.4 and 5

	$s_i = 0.1$	$s_i = 0.3$	$s_i = 0.5$	$s_i = 0.7$	$s_i = 0.9$
$\delta = 0$	0.36	0.34	0.33	0.31	0.31
$\delta = 0.1$	0.36	0.35	0.35	0.35	0.35
$\delta = 0.2$	0.36	0.36	0.36	0.37	0.38
$\delta = 0.3$	0.36	0.37	0.38	0.39	0.40
$\delta = 0.4$	0.36	0.38	0.39	0.41	0.43

C) Drawing from a wider range for σ

	$s_i = 0.1$	$s_i = 0.3$	$s_i = 0.5$	$s_i = 0.7$	$s_i = 0.9$
$\delta = 0$	0.65	0.64	0.63	0.62	0.61
$\delta = 0.1$	0.65	0.65	0.64	0.64	0.64
$\delta = 0.2$	0.65	0.65	0.66	0.66	0.67
$\delta = 0.3$	0.65	0.66	0.67	0.68	0.68
$\delta = 0.4$	0.65	0.66	0.68	0.69	0.70

Note: Baseline draws for σ are between 0.2 and 1, while the wider range is between 0 and 2.4.

Table 3. Probability that $\eta > \tilde{\beta}$ under selected scenarios

A) Drawing β between 0.4 and 2.5 (baseline)

	$s_i = 0.1$	$s_i = 0.3$	$s_i = 0.5$	$s_i = 0.7$	$s_i = 0.9$
$\delta = 0$	0.65	0.68	0.71	0.74	0.77
$\delta = 0.1$	0.65	0.66	0.68	0.71	0.73
$\delta = 0.2$	0.65	0.65	0.66	0.67	0.69
$\delta = 0.3$	0.65	0.63	0.63	0.63	0.63
$\delta = 0.4$	0.65	0.62	0.59	0.57	0.55

B) Drawing β between 0.4 and 5

	$s_i = 0.1$	$s_i = 0.3$	$s_i = 0.5$	$s_i = 0.7$	$s_i = 0.9$
$\delta = 0$	0.36	0.38	0.39	0.41	0.43
$\delta = 0.1$	0.36	0.37	0.38	0.39	0.40
$\delta = 0.2$	0.36	0.36	0.36	0.37	0.38
$\delta = 0.3$	0.36	0.35	0.35	0.35	0.35
$\delta = 0.4$	0.36	0.34	0.33	0.31	0.31

C) Drawing from a wider range for σ

	$s_i = 0.1$	$s_i = 0.3$	$s_i = 0.5$	$s_i = 0.7$	$s_i = 0.9$
$\delta = 0$	0.65	0.66	0.68	0.69	0.70
$\delta = 0.1$	0.65	0.66	0.67	0.68	0.68
$\delta = 0.2$	0.65	0.65	0.66	0.66	0.67
$\delta = 0.3$	0.65	0.65	0.64	0.64	0.64
$\delta = 0.4$	0.65	0.64	0.63	0.62	0.61

Note: Baseline draws for σ are between 0.2 and 1, while the wider range is between 0 and 2.4.

Table 4. Simulations for deterministic model - main results (in % deviation from competitive steady state)

		National case								Monetary union							
		β between 0.5 and 2.5				β between 0.5 and 5				β between 0.5 and 2.5				β between 0.5 and 5			
		Mean	Median	16%	84%	Mean	Median	16%	84%	Mean	Median	16%	84%	Mean	Median	16%	84%
Inflation	π_i	0.9	0.8	0.4	1.4	0.9	0.7	0.4	1.4	0.8	0.7	0.2	1.6	1.0	0.9	0.2	2.0
	π_k	0.9	0.7	0.4	1.4	0.9	0.7	0.4	1.4	1.8	0.8	0.2	1.6	1.0	0.8	0.4	1.5
	π_u	0.9	0.8	0.4	1.3	0.9	0.8	0.4	1.4	1.3	0.7	0.4	1.4	1.0	0.8	0.4	1.5
Output	y_i	-1.1	-1.0	-1.5	-0.7	-1.1	-1.0	-1.5	-0.7	-2.4	-1.0	-1.6	-0.7	-1.2	-1.0	-1.7	-0.7
	y_k	-1.1	-1.0	-1.5	-0.7	-1.1	-1.0	-1.5	-0.7	-0.6	-1.0	-1.6	-0.7	-1.1	-1.0	-1.6	-0.8
	y_u	-1.1	-1.1	-1.4	-0.8	-1.1	-1.0	-1.5	-0.8	-1.5	-1.0	-1.4	-0.7	-1.1	-1.1	-1.6	-0.8
Wage premium	$\bar{\Phi}_i$	0.8	0.6	0.3	1.2	0.7	0.6	0.3	1.2	1.3	0.5	0.2	1.4	0.8	0.6	0.2	1.4
	$\bar{\Phi}_k$	0.8	0.6	0.3	1.2	0.7	0.6	0.3	1.2	0.3	0.5	0.2	1.3	0.7	0.6	0.3	1.2
	$\bar{\Phi}_u$	0.8	0.6	0.3	1.2	0.7	0.6	0.3	1.2	0.8	0.5	0.3	1.4	0.8	0.6	0.3	1.2
Unemployment rate	u_i	1.7	1.5	1.1	2.4	1.7	1.5	1.1	2.3	3.7	1.5	1.0	2.4	1.9	1.6	1.0	2.7
	u_k	1.7	1.5	1.1	2.4	1.7	1.5	1.1	2.3	0.9	1.5	1.0	2.4	1.7	1.6	1.2	2.5
	u_u	1.7	1.7	1.3	2.1	1.7	1.6	1.2	2.3	2.3	1.6	1.1	2.2	1.8	1.6	1.2	2.4
Wage share	Ω_i	1.9	1.7	1.1	2.6	1.8	1.6	1.1	2.6	3.6	1.6	0.9	2.8	2.0	1.7	0.9	3.1
	Ω_k	1.9	1.6	1.1	2.6	1.8	1.6	1.1	2.6	0.9	1.5	0.9	2.7	1.9	1.7	1.1	2.7
	Ω_u	1.9	1.7	1.2	2.5	1.8	1.7	1.1	2.6	2.3	1.6	1.0	2.8	1.9	1.7	1.1	2.7
Interest rate	R	1.9	1.7	1.2	2.6	1.6	1.3	0.8	2.3	2.2	1.7	1.1	2.7	1.6	1.4	0.8	2.4

Table 5. Simulations for stochastic model - main results (in % deviation from competitive steady state)

		National case								Monetary union							
		β between 0.5 and 2.5				β between 0.5 and 5				β between 0.5 and 2.5				β between 0.5 and 5			
		Mean	Median	16%	84%	Mean	Median	16%	84%	Mean	Median	16%	84%	Mean	Median	16%	84%
Inflation	π_i	0.7	0.4	-4.0	5.7	0.6	0.4	-4.0	5.8	1.1	0.9	-25.1	27.3	-0.6	0.5	-18.6	19.6
	π_k	0.8	0.6	-6.5	8.5	1.1	0.5	-6.6	8.5	0.7	0.5	-7.0	9.0	0.7	0.6	-7.0	9.1
	π_u	0.8	0.6	-5.5	7.7	1.1	0.5	-5.8	7.6	0.7	0.5	-7.2	9.4	0.6	0.5	-7.4	9.5
Output	y_i	-1.0	-1.1	-6.5	4.7	-1.0	-1.2	-6.7	4.7	-0.8	-1.0	-12.9	11.2	-1.3	-1.2	-12.8	11.0
	y_k	-1.0	-1.1	-10.7	8.3	-1.1	-1.0	-10.4	8.2	-1.0	-1.0	-12.8	10.6	0.0	-1.1	-12.7	10.6
	y_u	-1.0	-1.1	-9.5	7.3	-1.1	-1.1	-9.3	7.2	-1.0	-0.9	-11.6	9.5	-0.1	-1.0	-11.6	9.4
Wage premium	$\bar{\Phi}_i$	0.8	0.5	-1.0	2.6	0.8	0.5	-1.0	2.5	0.7	0.5	-1.2	2.6	0.9	0.5	-1.1	2.6
	$\bar{\Phi}_k$	0.8	0.5	-1.0	2.7	0.8	0.5	-1.0	2.5	0.8	0.5	-1.0	2.6	-0.2	0.5	-1.0	2.5
	$\bar{\Phi}_u$	0.8	0.5	-1.1	2.7	0.8	0.5	-1.0	2.5	0.8	0.5	-0.9	2.4	-0.1	0.5	-0.8	2.4
Unemployment rate	u_i	1.8	1.9	-7.6	11.3	1.8	1.7	-7.5	11.1	1.6	1.4	0.9	2.5	2.3	1.6	1.0	2.7
	u_k	1.8	1.7	-4.9	8.6	1.8	1.6	-4.9	8.4	1.8	1.6	1.2	2.4	0.1	1.6	1.2	2.5
	u_u	1.8	1.7	-4.9	8.5	1.8	1.6	-4.9	8.5	1.7	1.6	1.2	2.4	0.3	1.6	1.2	2.5
Wage share	Ω_i	1.8	2.0	-3.2	6.5	1.8	2.0	-3.1	6.6	1.6	1.8	-13.0	16.2	2.2	2.2	-12.7	16.1
	Ω_k	1.8	2.0	-9.2	12.8	1.9	1.8	-8.9	12.6	1.7	1.7	-12.4	16.2	-0.1	2.0	-12.1	15.8
	Ω_u	1.8	2.0	-8.1	11.6	1.9	1.8	-7.8	11.6	1.7	1.6	-11.0	14.6	0.1	1.9	-10.8	14.6
Interest rate	R	1.6	1.3	-16.4	20.3	1.4	1.1	-11.8	14.8	1.5	1.3	-19.4	22.7	0.3	1.3	-14.3	17.4

Table 6. Simulations for the wage premium for alternative parameter assumptions (in % deviation from competitive steady state)

	National case								Monetary union							
	β between 0.5 and 2.5				β between 0.5 and 5				β between 0.5 and 2.5				β between 0.5 and 5			
	Mean	Median	16%	84%	Mean	Median	16%	84%	Mean	Median	16%	84%	Mean	Median	16%	84%
A) $\chi = 500$																
Deterministic model																
$\bar{\Phi}_i$	0.8	0.6	0.3	1.2	0.7	0.6	0.3	1.2	1.3	0.5	0.2	1.4	0.8	0.6	0.2	1.4
$\bar{\Phi}_k$	0.8	0.6	0.3	1.2	0.7	0.6	0.3	1.2	0.3	0.5	0.2	1.3	0.7	0.6	0.3	1.2
$\bar{\Phi}_u$	0.8	0.6	0.3	1.2	0.7	0.6	0.3	1.2	0.8	0.5	0.3	1.4	0.8	0.6	0.3	1.2
Stochastic model																
$\bar{\Phi}_i$	0.7	0.5	-1.0	2.5	0.7	0.5	-1.1	2.6	0.7	0.5	-1.1	2.5	0.8	0.5	-1.1	2.6
$\bar{\Phi}_k$	0.7	0.4	-1.1	2.5	0.7	0.5	-1.0	2.6	0.7	0.4	-1.1	2.5	0.5	0.5	-1.1	2.6
$\bar{\Phi}_u$	0.7	0.5	-0.6	2.0	0.7	0.5	-0.5	2.1	0.7	0.5	-0.6	2.0	0.7	0.5	-0.6	2.1
B) $N_i = N_k = 1$																
Deterministic model																
$\bar{\Phi}_i$	0.8	0.6	0.3	1.2	0.7	0.6	0.3	1.2	0.8	0.5	0.2	1.4	0.8	0.6	0.2	1.3
$\bar{\Phi}_k$	0.8	0.6	0.3	1.2	0.7	0.6	0.3	1.2	0.8	0.5	0.2	1.4	0.9	0.6	0.2	1.3
$\bar{\Phi}_u$	0.8	0.6	0.3	1.2	0.7	0.6	0.3	1.2	0.8	0.5	0.3	1.4	0.8	0.6	0.3	1.3
Stochastic model																
$\bar{\Phi}_i$	0.7	0.5	-1.1	2.6	0.7	0.4	-1.1	2.5	0.8	0.5	-1.1	2.6	0.7	0.5	-1.1	2.6
$\bar{\Phi}_k$	0.7	0.5	-1.0	2.6	0.8	0.5	-1.1	2.6	0.5	0.5	-1.1	2.6	0.8	0.5	-1.1	2.7
$\bar{\Phi}_u$	0.7	0.5	-0.5	2.1	0.7	0.5	-0.6	2.1	0.7	0.5	-0.6	2.1	0.7	0.5	-0.6	2.1
C) Wider range for σ																
Deterministic model																
$\bar{\Phi}_i$	0.5	0.3	0.1	0.8	0.5	0.3	0.1	0.8	0.3	0.2	0.1	0.8	0.5	0.2	0.1	0.9
$\bar{\Phi}_k$	0.5	0.3	0.1	0.8	0.5	0.3	0.1	0.8	0.5	0.2	0.1	0.8	0.4	0.2	0.1	0.9
$\bar{\Phi}_u$	0.5	0.3	0.1	0.8	0.5	0.3	0.1	0.8	0.4	0.2	0.1	0.8	0.5	0.2	0.1	0.9
Stochastic model																
$\bar{\Phi}_i$	0.5	0.2	-0.6	1.4	0.5	0.2	-0.5	1.4	0.5	0.2	-0.5	1.4	0.5	0.2	-0.5	1.4
$\bar{\Phi}_k$	0.5	0.2	-0.5	1.4	0.5	0.2	-0.6	1.4	0.5	0.2	-0.5	1.4	0.5	0.2	-0.5	1.4
$\bar{\Phi}_u$	0.5	0.2	-0.3	1.1	0.5	0.2	-0.3	1.2	0.5	0.2	-0.3	1.2	0.5	0.2	-0.3	1.2

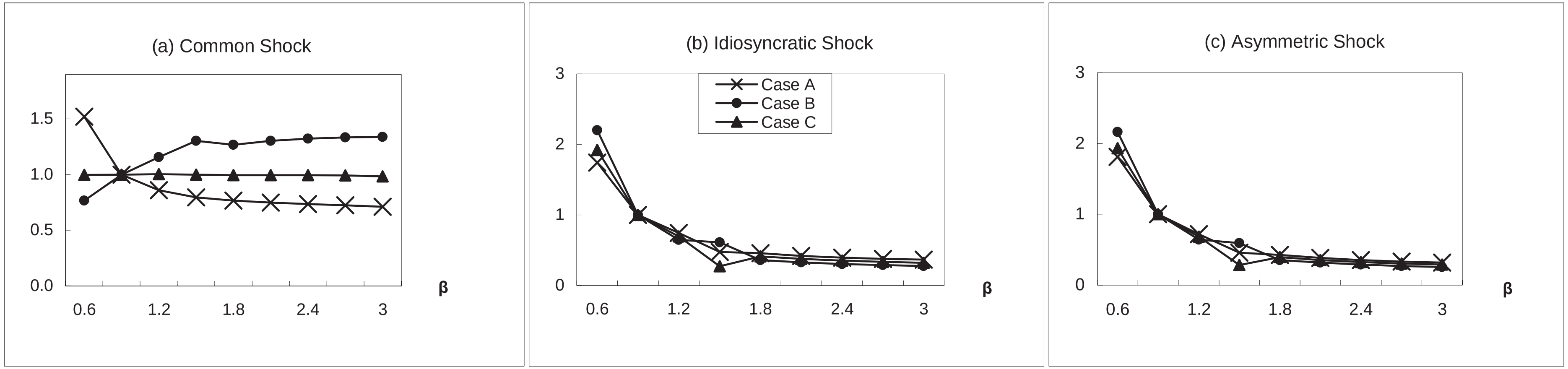

Fig. 1. Relative welfare under technology shocks: Sensitivity to β

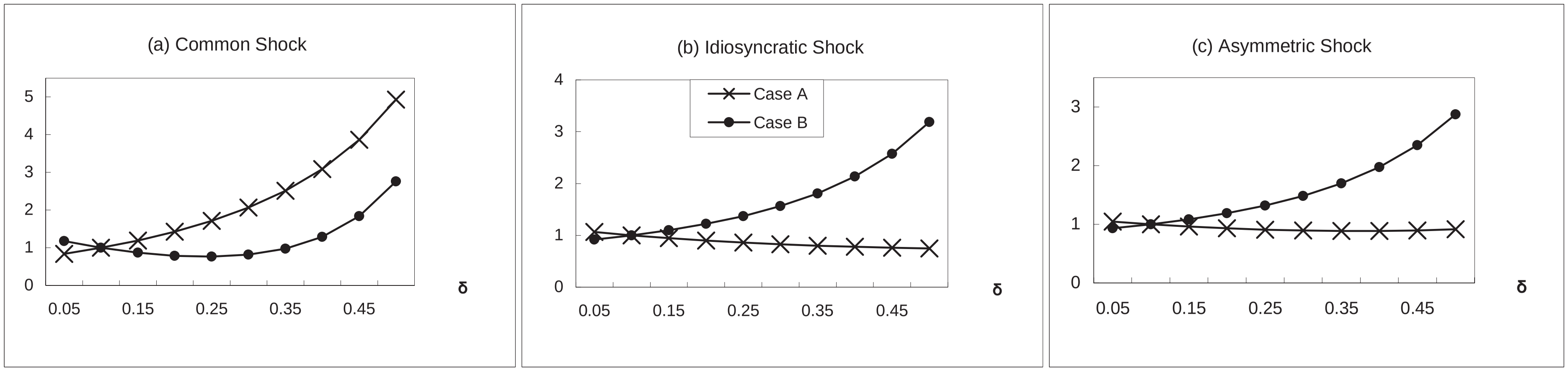

Fig. 2. Relative welfare under technology shocks: Sensitivity to δ

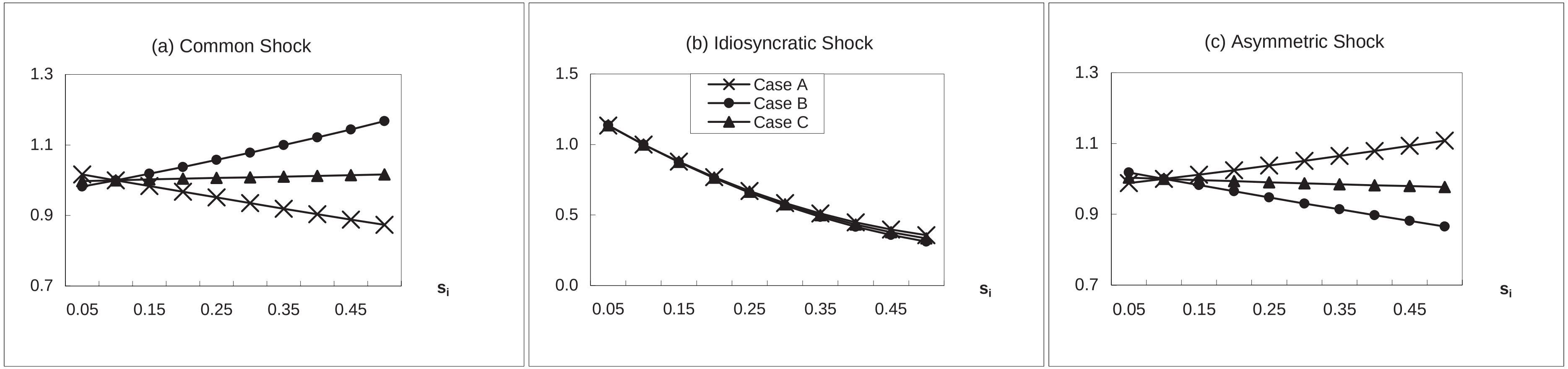

Fig. 3. Relative welfare under technology shocks: Sensitivity to s_i

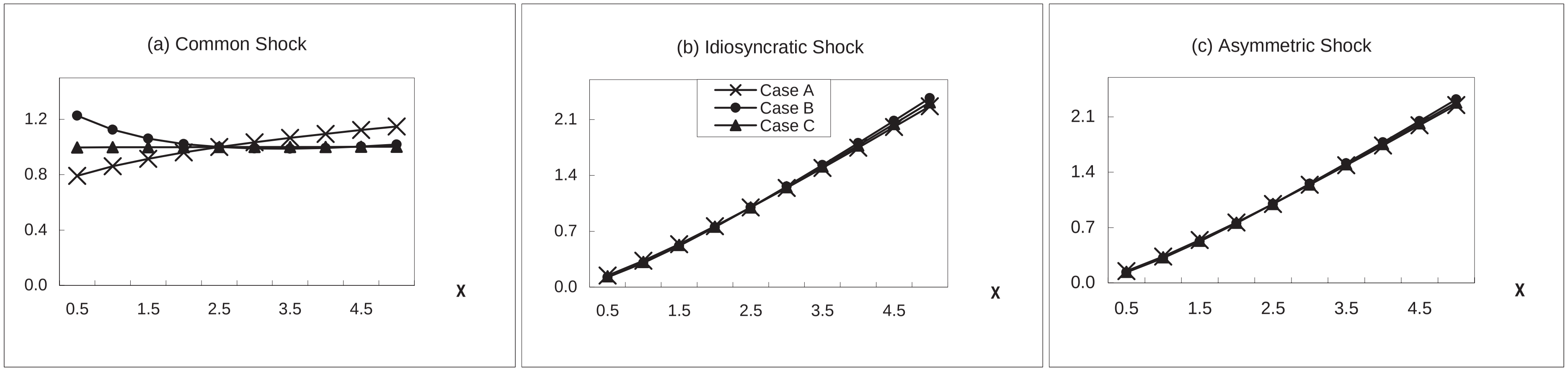

Fig. 4. Relative welfare under technology shocks: Sensitivity to χ

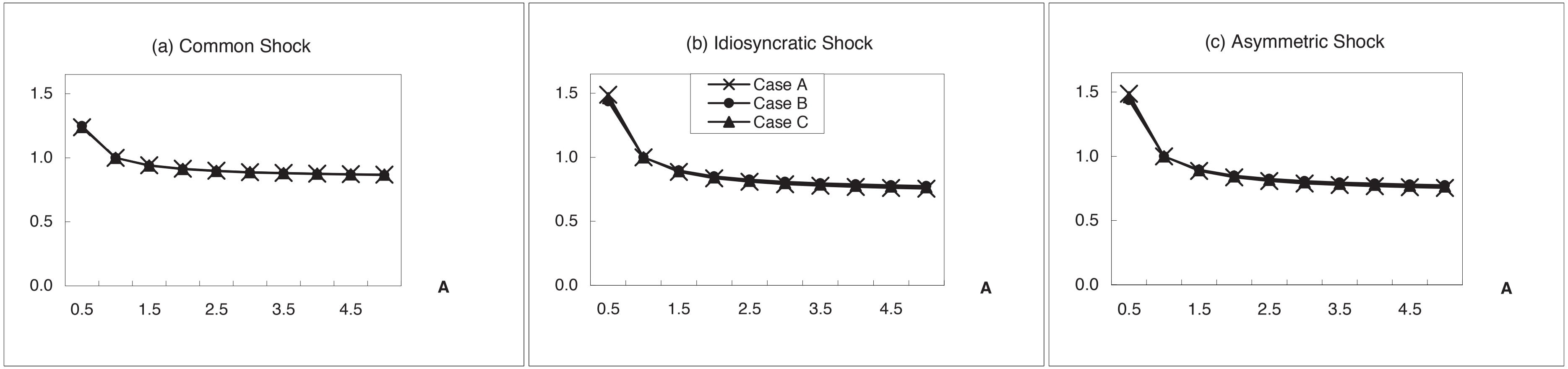

Fig. 5. Relative welfare under technology shocks: Sensitivity to A

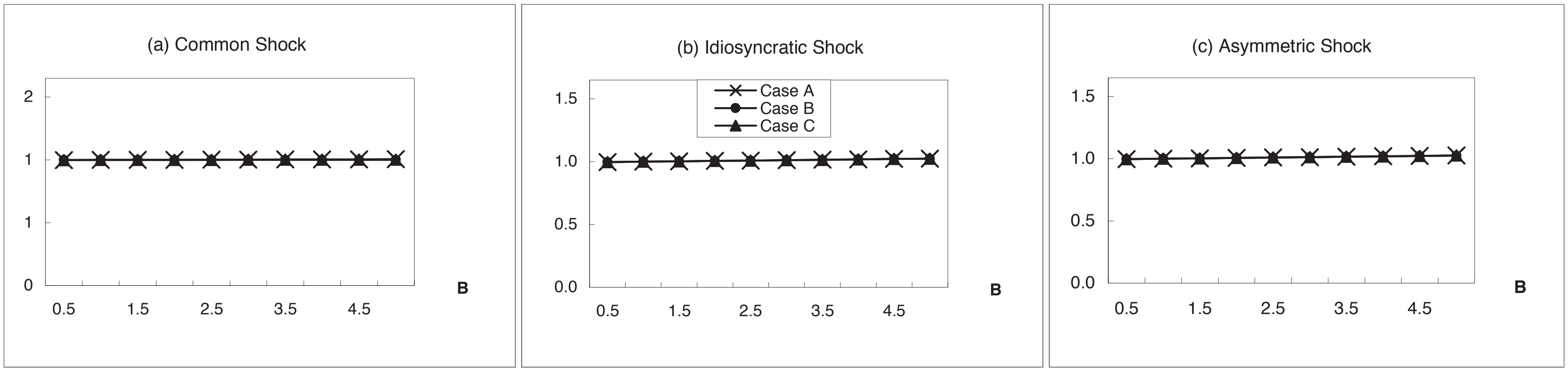

Fig. 6. Relative welfare under technology shocks: Sensitivity to B

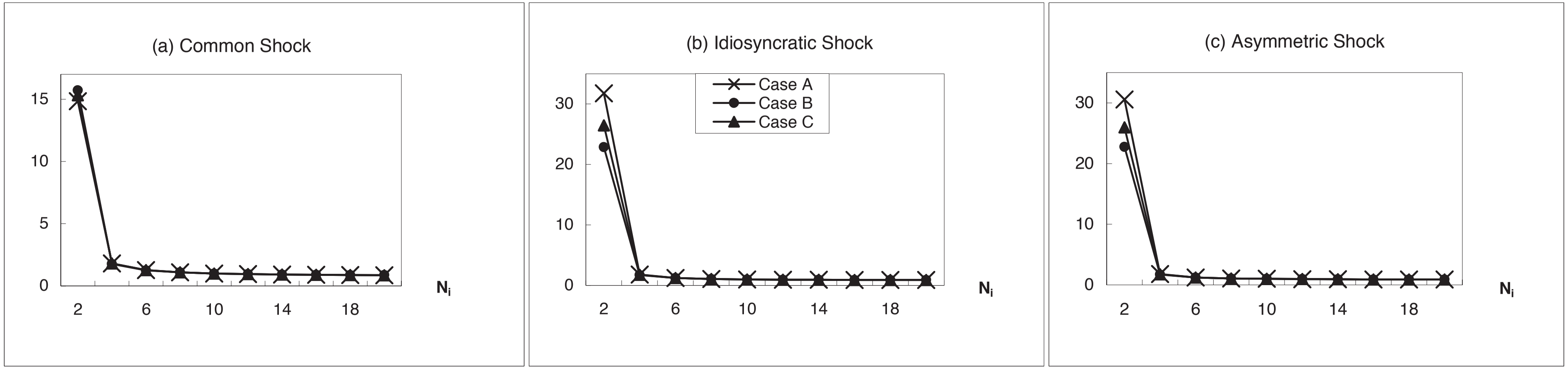

Fig. 7. Relative welfare under technology shocks: Sensitivity to N_i

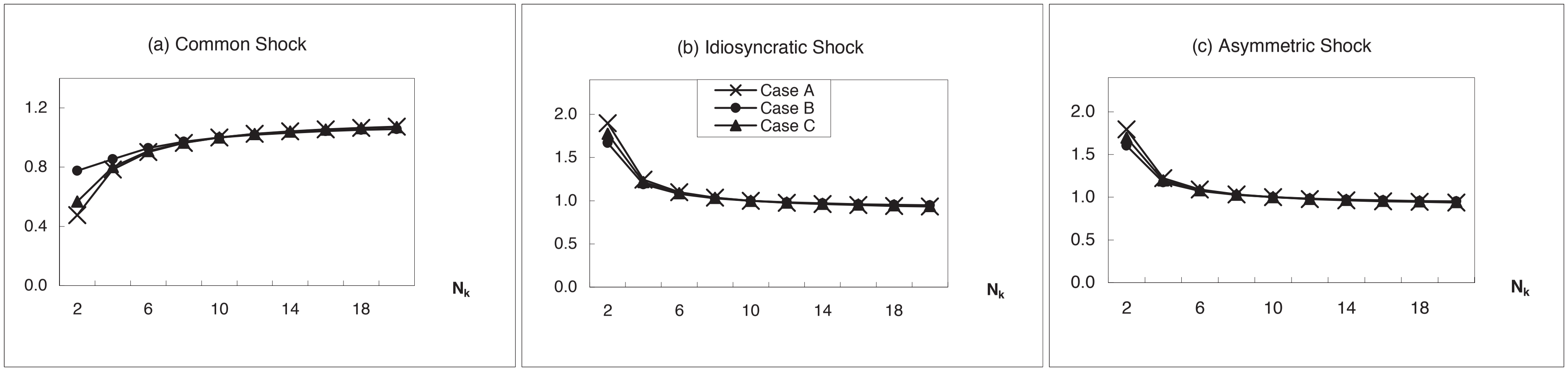

Fig. 8. Relative welfare under technology shocks: Sensitivity to N_k

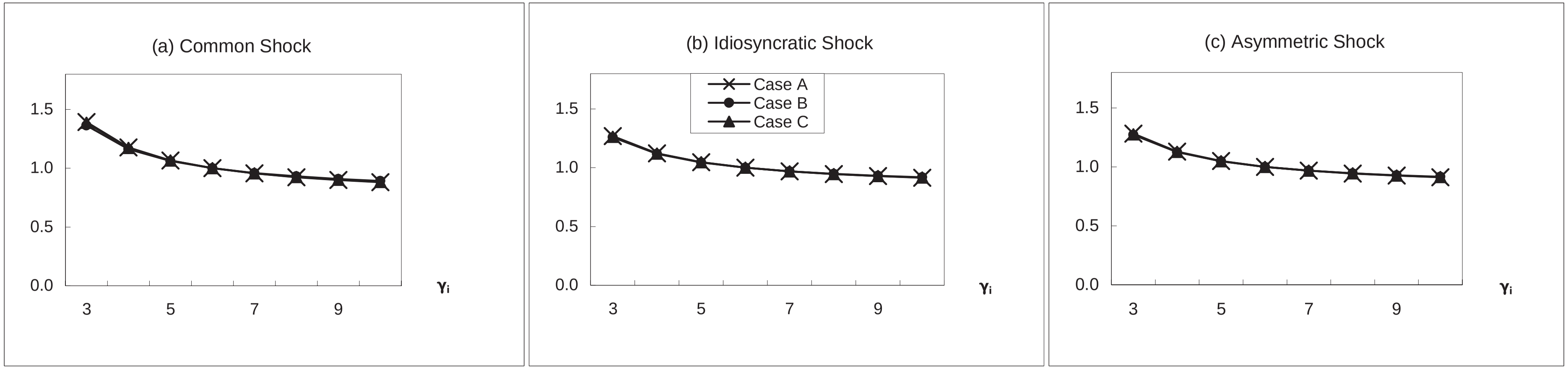

Fig. 9. Relative welfare under technology shocks: Sensitivity to γ_i

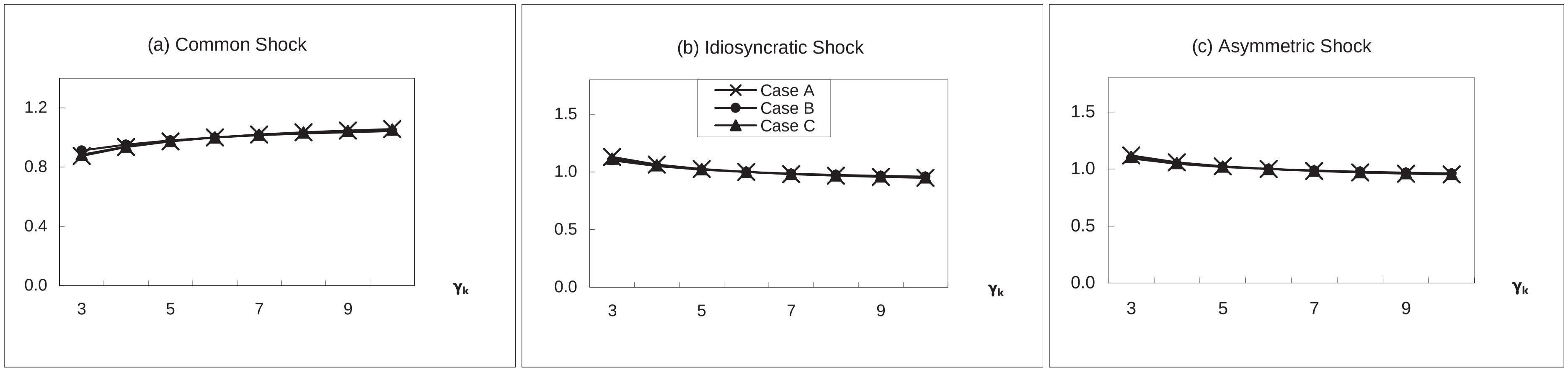

Fig. 10. Relative welfare under technology shocks: Sensitivity to γ_k

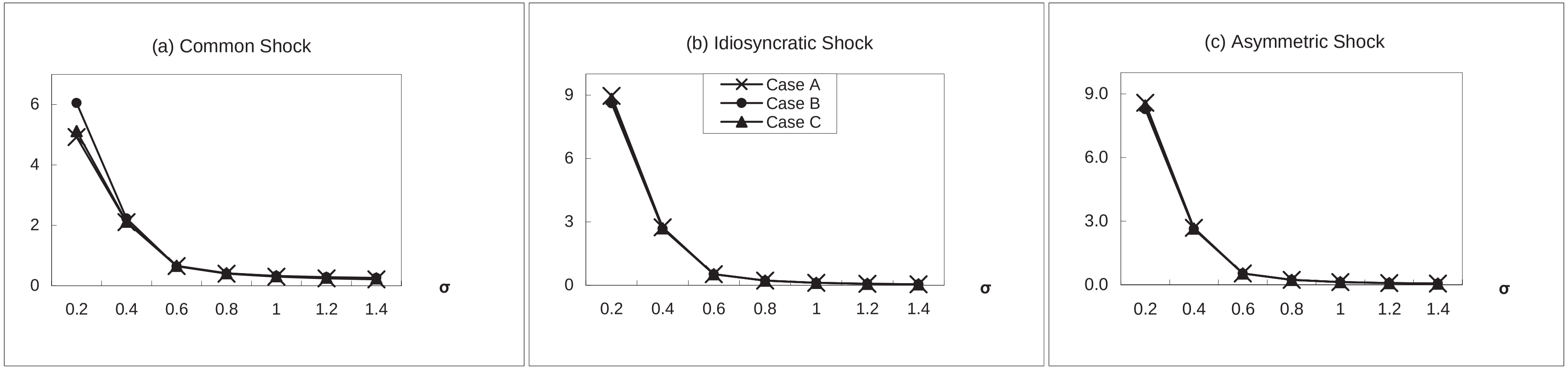

Fig. 11. Relative welfare under technology shocks: Sensitivity to σ

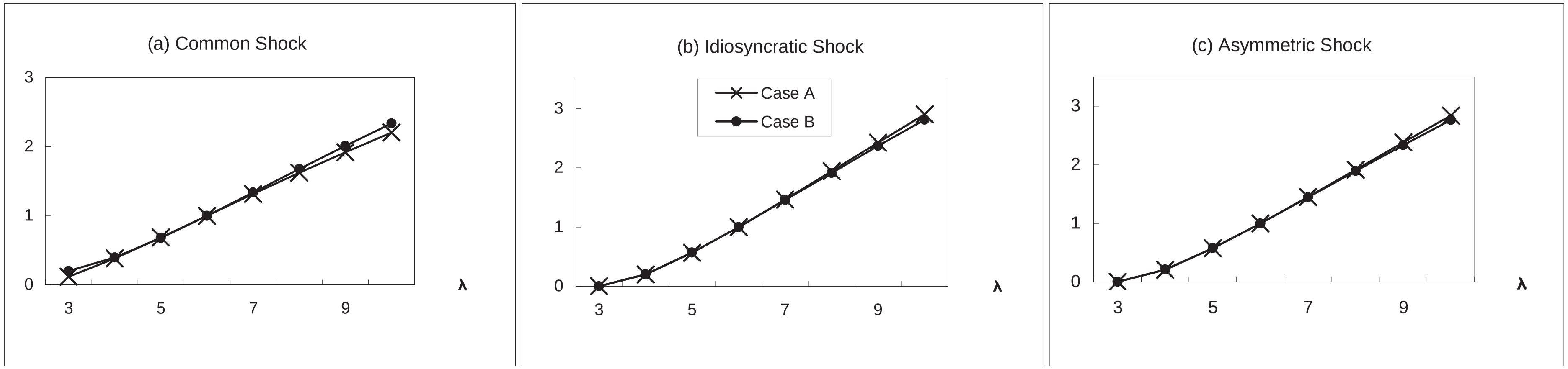

Fig. 12. Relative welfare under technology shocks: Sensitivity to λ

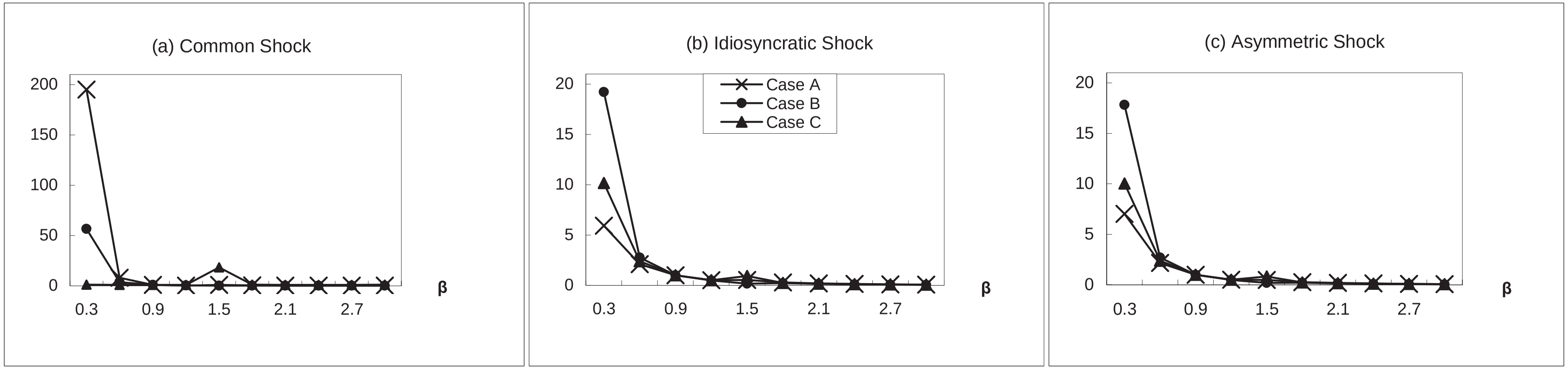

Fig. 13. Welfare loss under demand shocks: Sensitivity to β

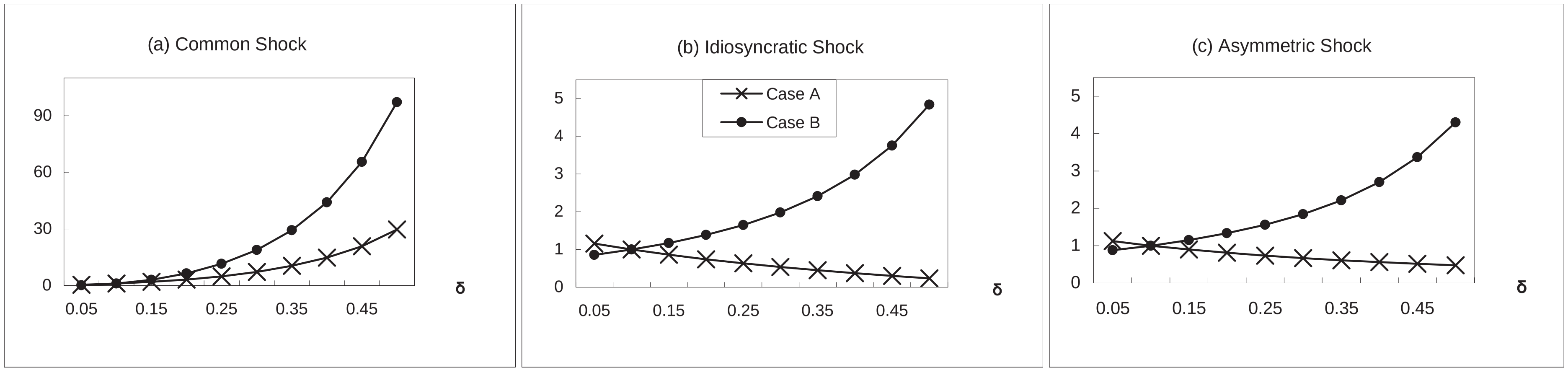

Fig. 14. Welfare loss under demand shocks: Sensitivity to δ

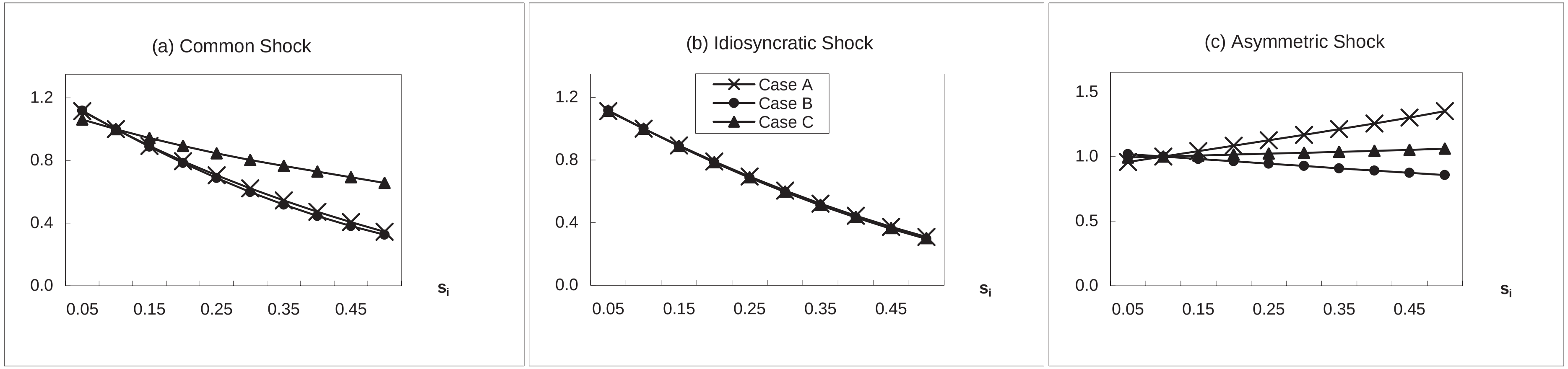

Fig. 15. Welfare loss under demand shocks: Sensitivity to s_i

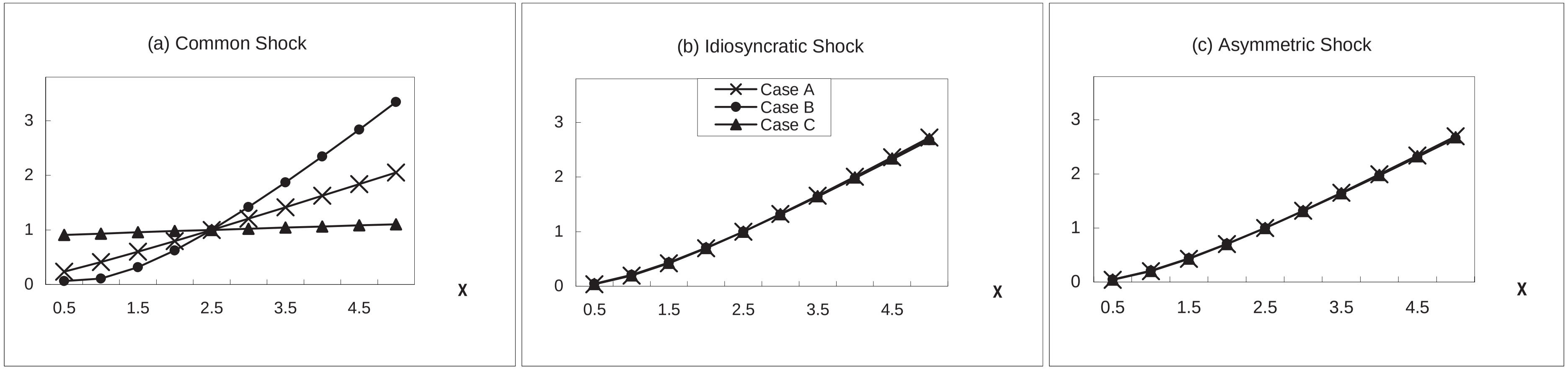

Fig. 16. Welfare loss under demand shocks: Sensitivity to χ

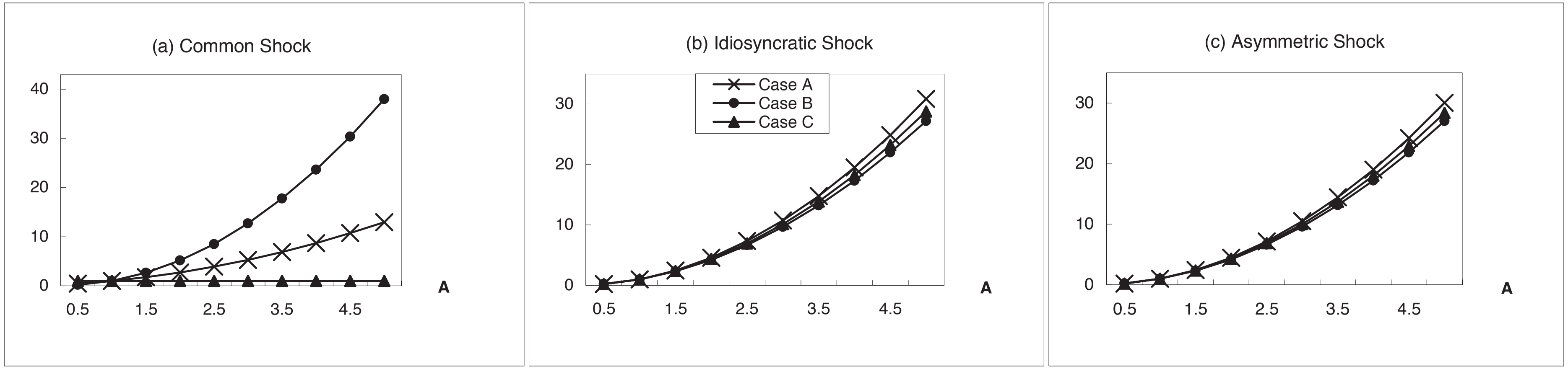

Fig. 17. Welfare loss under demand shocks: Sensitivity to A

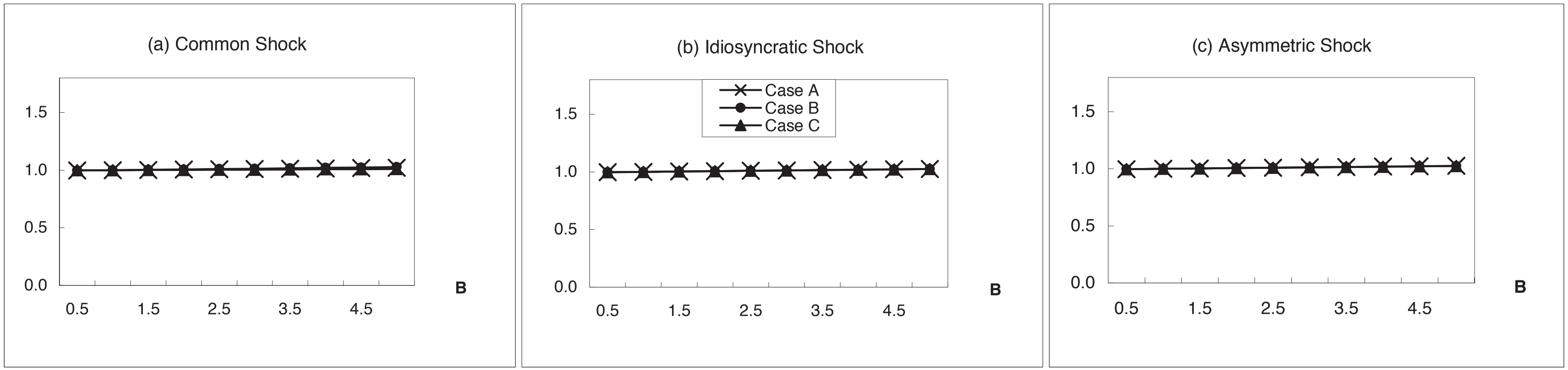

Fig. 18. Welfare loss under demand shocks: Sensitivity to B

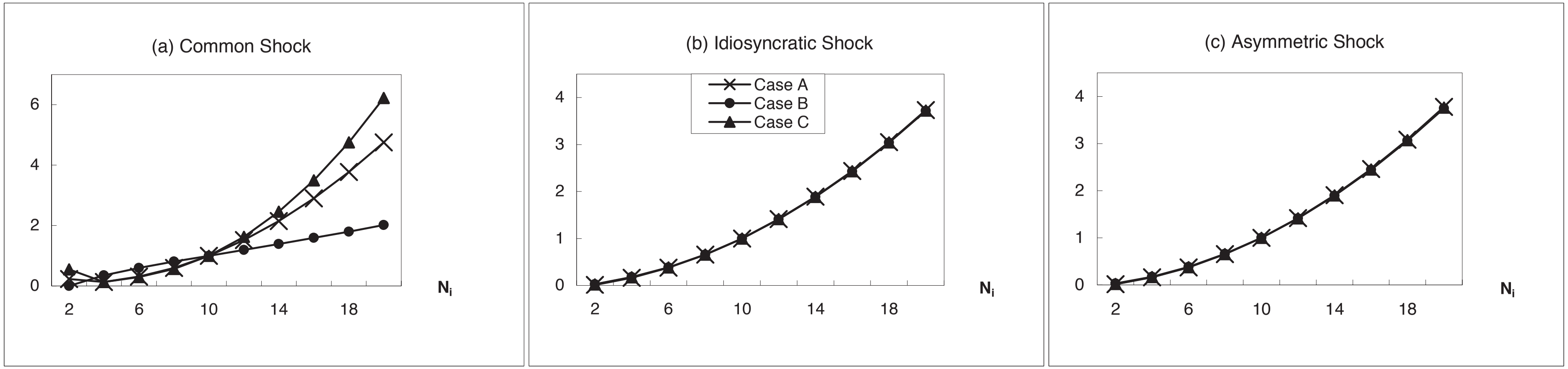

Fig. 19. Welfare loss under demand shocks: Sensitivity to N_i

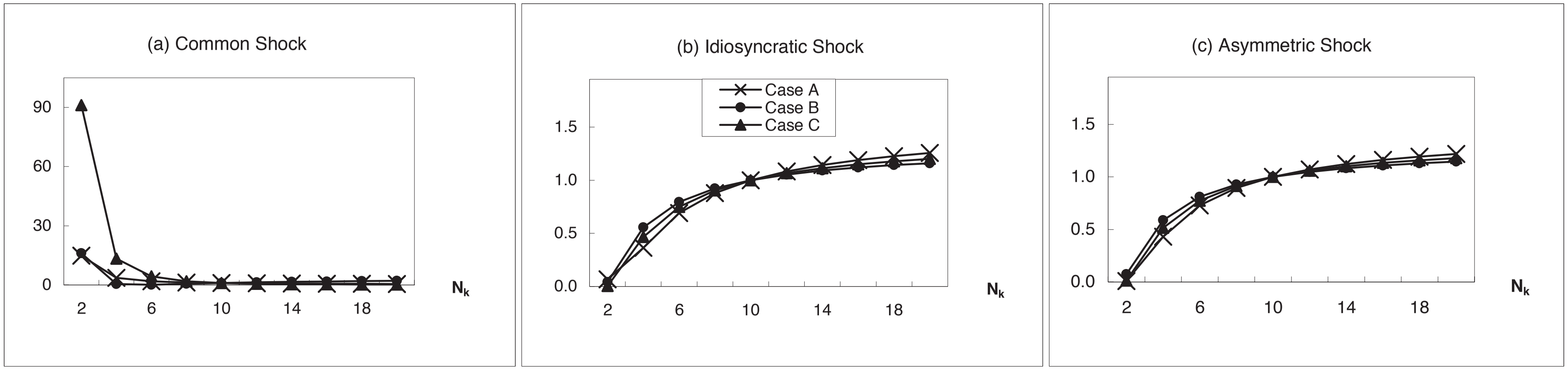

Fig. 20. Welfare loss under demand shocks: Sensitivity to N_k

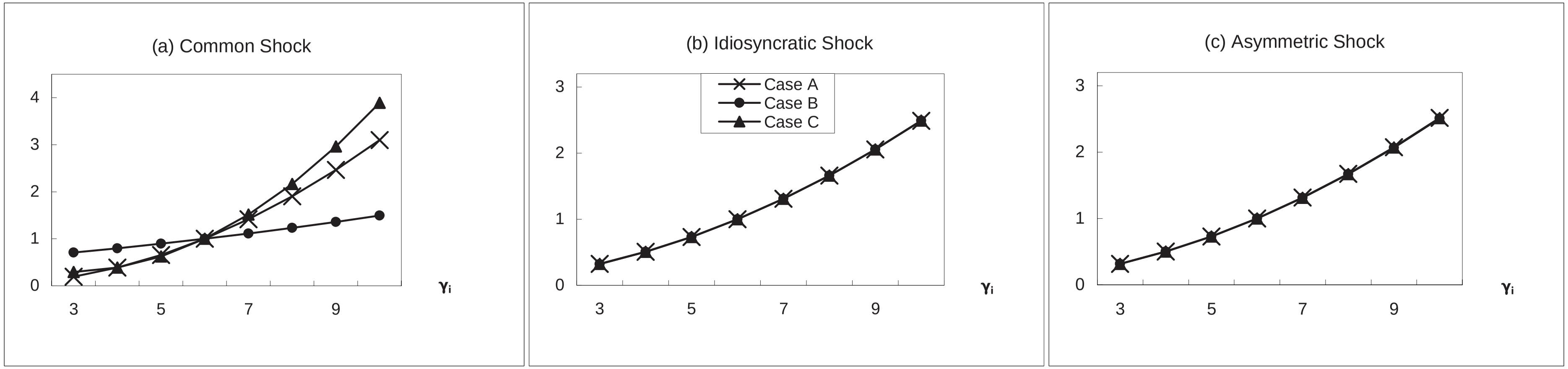

Fig. 21. Welfare loss under demand shocks: Sensitivity to γ_i

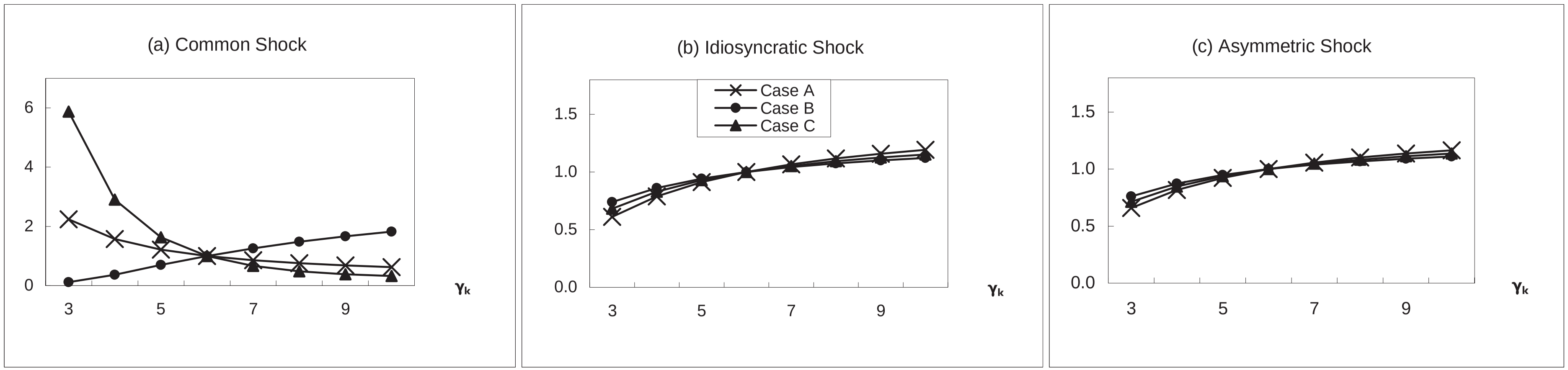

Fig. 22. Welfare loss under demand shocks: Sensitivity to γ_k

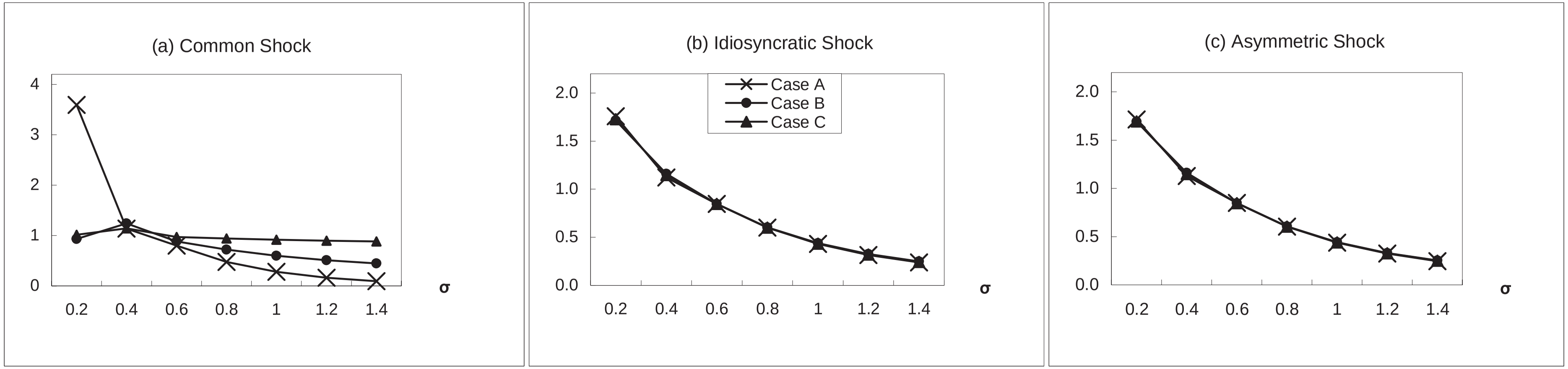

Fig. 23. Welfare loss under demand shocks: Sensitivity to σ

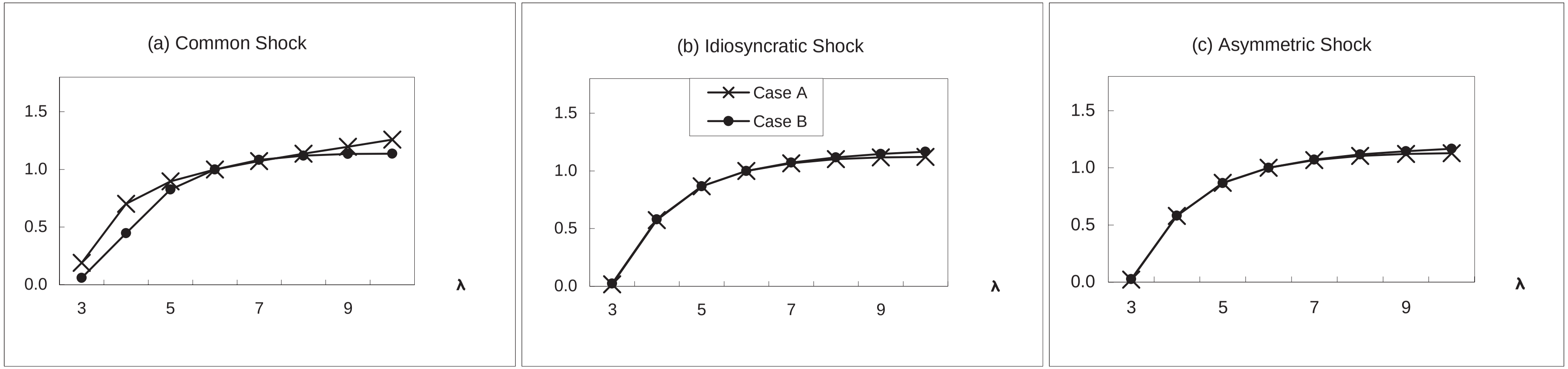

Fig. 24. Welfare loss under demand shocks: Sensitivity to λ

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